The Hall Committee.

The Library Committee.

The Phillips Prize Essay Committee.

The Librarian laid upon the table the list of donations to the Library, and thanks were ordered therefor.

The Society was then adjourned by the presiding officer.

ON THE OSTEOLOGY OF THE STRIGES.

[STRIGIDÆ AND BUBONIDÆ.]

(Plates X–XVII.)

BY R. W. SHUFELDT, M.D.

(*Read December 7, 1900.*)

INTRODUCTION.

Of all my published scientific papers, or in fact of any of my writings, the first to appear was a memoir devoted to the *Osteology of Speotyto cunicularia hypogæa* (Bull. U. S. Geol. and Geogr. Surv. of the Terr., Dept. of the Interior. Vol. vi, No. 1. Washington, 1881). This contribution to the anatomy of the Burrowing Owl was quite complete, and illustrated by many figures given principally upon three full-page lithographic plates. It was done, however, far from all civilization, the museums and the libraries, and therefore offered but few comparisons in its pages with the osteology of other species of Owls.

This paper underwent a partial revision at my hands and appeared again in my work entitled *Contributions to the Anatomy of Birds* (12th Ann. Rep. of the late U. S. Geol. and Geogr. Surv. of the Terr. [Hayden's]. Washington: Govt. Printing Office, Oct., 1882. Author's Edition). Some little improvement was made in the paper, but the same plates and figures were reproduced, and no general comparisons included in the research. In the present memoir a large number of osteological comparisons have been made, substantially based upon the facts brought out in the original and revised issues of the *Speotyto* article, and the characters found upon examination to present themselves in the skeletons of other American *Strigidæ*, specimens of which at this time are not lacking

in either my private collection or in the collections of the U. S. National Museum at Washington. All the figures, however, illustrating the early papers on the osteology of the Burrowing Owl have in the present memoir been omitted, it not having been thought necessary to republish them, as they can be consulted by any student of the subject in the above quoted publications. This does not, however, apply to the text matter of the original article, for it is taken up in the present work and incorporated in the general comparisons made throughout, wherein the osteological characters of all the American species of Owls have been contrasted and employed to meet the ends of taxonomy. Apart from a few brief notes, the anatomy of Owls was not touched by me again until 1889, when in the *Journal of Morphology* (Vol. iii, No. 1. pp. 115–125, Pl. vii) I contributed a paper on the Burrowing Owl, entitled *Notes on the Anatomy of the Speotyto cunicularia hypogæa;* but little was said in it about the osteology of the species.

Several years later I published in one place or another a number of papers treating of fossil birds, and in some of these descriptions of fossil bones of Owls are given, notably of a *Bubo* in my memoir on *A Study of the Fossil Avifauna of the Equus Beds of the Oregon Desert* (*Jour. Acad. Nat. Sci. Phila.*, Vol. ix, Pls. xv–xvii, 4to, Phila., Oct., 1892, pp. 389–425). Quite a number of popular papers were also published about the American species of the *Strigidæ*, but nothing of a nature to be considered here. Indeed, up to the present writing I have published no paper requiring further notice in this place, beyond my memoir entitled *Professor Collett on the Morphology of the Cranium and the Auricular Openings in the North-European Species of the Family Strigidæ* (*Jour. Morphology*, Vol. xvii, No. 1, Boston, 1900). This somewhat elaborate production, upward of one hundred printed pages, is illustrated by thirty lithographic figures of the skulls and plucked heads of Owls, and some seven or eight text figures of a similar character. A number of genera and species are thus shown, but none of those figures are reproduced here, for the same reason as the one given in a former paragraph of this Introduction.

The present memoir, however, claims to be a very general contribution to the study and comparison of the osteological characters presented on the part of the skeletons of all the North American species, or at least genera, of *Strigidæ*. The most of the text figures here offered have never been published by me heretofore, and the

same applies to the thirty figures given on the Plates. In fact, in the case of the latter no one of them has ever been given before in any memoir anywhere. For the first time now we have here the relations of the cranial segments at the base of the skull in the nestling *Bubo;* the internal view of the skull in the adult; the cranium of *Megascops* and skeleton of *Micropallas* figured, and a good many other specimens of the bones of Owls which have never been published before. It is believed that these will be found to be useful not only to the comparative osteologist, but to the researcher in the fields of avian palæontology. Further, it will be found that in the present memoir descriptions have been given and intercomparisons made of the osteological characters presented on the part of many of the species of the genera of *Strix*, *Asio*, *Surnium*, *Scotiapex*, *Nyctala*, *Megascops*, *Bubo*, *Nyctea*, *Surnia*, *Speotyto*, *Glaucidium* and *Micropallas*, the whole being completed with a brief discussion of the probable affinities of the *Strigidæ* and their place as a group in the system.

WASHINGTON, D.C., November 21, 1900. R. W. S.

Owls of a number of genera, represented by a variety of species, are to be found in the avifauna of the United States. That North American alucoline type of the Barn Owls, *Strix pratincola*, ranges throughout the southern and warmer parts of the country. The genus *Asio* is represented by two species, *Syrnium* by two and a subspecies, while far north *Scotiapex cincrea* and *Scotiapex c. lapponica* are occasionally found. Of the smaller Owls, *Nyctala* is represented by one species and a subspecies, the best known one being *N. acadica*, now becoming quite rare. Screech Owls of the genus *Megascops* are especially numerous and of wide geographical range, ornithologists having recognized at the present time two species of them and at least half a dozen subspecies, but some of the latter require an eye highly educated in the matter of the fine discrimination of shades of color to distinguish them.

Great Horned Owls of the genus *Bubo* have the well-known *Bubo virginianus*, of which there seem to be at least three fairly well-marked geographical races or subspecies—a Western one (*subarcticus*), one in the Fur Countries (*arcticus*), and a Northwest Coast region variety, which has also been taken in Labrador (*saturatus*). We also have the magnificent Snowy Owl (*Nyctea nyctea*), as well as two Hawk Owls (*Surnia*), and those other Owls, known as

"Burrowing Owls," of the genus *Speotyto*, of which there are two varieties. Finally, in the Western and Southwestern regions we meet with the highly interesting little Pygmy and Elf Owls—two of the genus *Glaucidium* and the still more diminutive Elf, *Micropallas whitneyi*.

The Striges constitute a very cosmopolitan group of birds, and a wonderfully monomorphic one, there being hardly an aberrant form in the entire suborder the world over. But even at the present writing the classification of these birds is in a condition anything but satisfactory, and in times not long gone by the nomenclature of Owls was something quite past comprehension and utterly confusing.

Presently I shall quote some authorities in these matters when I come to say a few words upon the Owls in general, but right here, be it said, that beyond that the present memoir will have but little to do with the unraveling of this perplexing taxonomy and nomenclature. For the purpose of designating species and genera, I here adopt the arrangement set forth in the Check List of the American Ornithologists' Union—the last edition. Huxley, in his celebrated paper, published in the *Proceedings* of the Zoölogical Society of London in 1867, says that his Actomorphæ is a division which is equivalent

"to the 'Raptores' of Cuvier—an eminently natural assemblage, and yet one the members of which, as the preceding enumeration of their character shows, vary in most important particulars.

"They appear to me to fall naturally into four well-defined primary groups—the *Strigidæ*, the *Cathartidæ*, the *Gypætidæ* and the *Gypogeranidæ*. But this arrangement is so different from that ordinarily adopted, that I shall proceed to justify it by enumerating the principal circumstances in which the members of the several divisions agree with one another and differ from the rest."

This is first followed by a fairly complete *résumé* of the osteological and other characters of the Owls, but as many important skeletal characters have, since that paper was published, been described by ornithotomists, we will omit here Prof. Huxley's synopsis in these matters, and present the fuller and more recent remarks of Prof. Newton and others in the premises.

In his admirable article "Ornithology" in the Ninth Edition of the *Encyclopædia Britannica* (v. xviii, p. 47), Prof. Newton says that "It has so long been the custom to place the Owls next to the diurnal Birds-of-Prey that any attempt to remove them from that position cannot

fail to incur criticism. Yet when we disregard their carnivorous habits and certain modifications which may possibly be thereby induced, we find almost nothing of value to indicate relationship between them. That the *Striges* stand quite independently of the *Accipitres* as above limited can hardly be doubted, and, while the *Psittaci* or Parrots would on some grounds appear to be the nearest allies of the *Accipitres*, the nearest relations of the Owls must be looked for in the multifarious group *Picariæ*. Here we have the singular *Steotornis*, which, long confounded with the *Caprimulgidæ*, has at last been recognized as an independent form, and one cannot but think that it has branched off from a common ancestor with the Owls."

And the same excellent authority in the volume just quoted, under the article "Owl" further says, on page 89, that

"The Owls form a very natural assemblage, and one about the limits of which no doubt has for a long time existed. Placed by nearly all systematists for many years as a Family of the Order *Accipitres* (or whatever may have been the equivalent term used by the particular taxonomers), there has been of late a disposition to regard them as forming a group of higher rank. On many accounts it is plain that they differ from the ordinary diurnal Birds-of-Prey, more than the latter do among themselves; and, though in some respects Owls have a superficial likeness to the *Goatsuckers*, and a resemblance more deeply seated to the *Guacharo*, even the last has not been made out to have any strong affinity to them.[1]

"A good deal is therefore to be said for the opinion which would regard the Owls as forming an independent Order, or at any rate Suborder, *Striges*. Whatever be the position assigned to the group, its subdivision has always been a fruitful matter of discussion, owing to the great resemblance obtaining among all its members, and the existence of safe characters for its division has only lately been at all generally recognized.

"By the older naturalists, it is true, Owls were divided, as was first done by Willughby, into two sections—one in which all the species exhibit tufts of feathers on the head, the so-called 'ears' or 'horns,' and the second in which the head is not tufted. The artificial and therefore untrustworthy nature of this distinction was shown by Isidore Geoffrey St. Hilaire (*Ann. Sc. Naturelles*, xxi, pp. 194–203) in 1830; but he did not do much good in the arrangement of the Owls which he then proposed; and it was hardly until the publication ten years later of Nitzsch's *Pterylographie* that rational grounds on which to base a divis-

[1] This last remark rather borders upon inconsistency when strictly taken with what this writer has said in his article "Ornithology" quoted in a former paragraph above.

ion of the Owls were adduced. It then became manifest that two very distinct types of pterylosis existed in the group, and further it appeared that certain differences, already partly shown by Berthold (*Beitr. zur Anatomie*, pp. 166, 167), of sternal structure coincided with the pterytological distinctions. By degrees other significant differences were pointed out, till, as summed up by Prof. Alphonse Milne-Edwards (*Ois. foss. de la France*, ii, pp. 474–492), there could no longer be any doubt that the bird known in England as the Screech Owl or Barn Owl, with its allies, formed a section which should be most justifiably separated from all the others of the group then known.

"Space is here wanting to state particularly the pterytological distinctions which will be found described at length in Nitzsch's classical work (*English Translation*, pp. 70, 71), and even the chief osteological distinctions must be only briefly mentioned. These consist in the Screech Owl section wanting any manubrial process in front of the sternum, which has its broad keel joined to the clavicles united as a furcula, while posteriorly it presents an unbroken outline.

"In the other section, of which the bird known in England as the Tawny or Brown Owl is the type, there is a manubrial process; the furcula, far from being joined to the keel of the sternum, often consists but of two stylets which do not even meet one another; and the posterior margin of the sternum presents two pairs of projections, one pair on each side, with corresponding fissures between them. Furthermore, the Owls of the same section show another peculiarity in the bone usually called the tarsus. This is a bony ring or loop bridging the channel in which lies the common extensor tendon of the toes—which does not appear in the Screech Owl section any more than in the majority of birds. The subsequent examination by M. Milne-Edwards (*Nouv. Arch. du Muséum*, ser. 2, i, pp. 185–200) of the skeleton of an Owl known as *Phodilus* (more correctly *Photodilus*) *badius*, hitherto attached to the Screech Owl section, shows that, though in most of its osteological characters it must be referred to the Tawny Owl section, in several of the particulars mentioned above it resembles the Screech Owls, and therefore we are bound to deem it a connecting link between them. The pterytological characters of *Photodilus* seem not to have been investigated, but it is found to want the singular bony tarsal loop as well as the manubrial process, while its clavicles are not united into a furcula and do not meet the keel, and the posterior margin of the sternum has processes and fissures like those of the Tawny Owl section. *Photodilus* having thus to be removed from the Screech Owl section, Prof. Milne-Edwards has been able to replace it by a new form *Heliodilus* from Madagascar, described at length by him in M. Grandidier's great work on the natural history of that island (*Oiseaux*, i, pp. 113–118). The unexpected results thus obtained preach caution in regard to

the classification of other Owls, and add to the misgivings that every honest ornithologist must feel as to former attempts to methodize the whole group—misgivings that had already arisen from the great diversity of opinion displayed by previous classifiers, no two of whom seem able to agree.

"Moreover, the difficulties which beset the study of the Owls are not limited to their respective relations, but extend to their scientific terminology, which has long been in a state so bewildering that nothing but the strictest adherence to the very letter of the laws of nomenclature, which are approved in principle by all but an insignificant number of naturalists, can clear up the confusion into which the matter has been thrown by heedless or ignorant writers—some of those who are in general most careful to avoid error being not wholly free from blame in this respect."

Did my space but admit of it, I would here republish even still more of this admirable article of Prof. Newton's, as in my opinion it constitutes one of the most able short contributions that has ever been added to the literature of this subject.

Upon consulting the Plates and text of so distinguished an authority's work as Prof. Max Fürbringer's *Untersuchungen zur Morphologie und Systematik der Vögel*, we are to note that there the *Caprimulgi* and *Striges* are considered as arising from a common ancestral stock, the suborder *Coraciiformes* of the Order *Coracornithes*, and this last-named division is quite apart from the Order *Pelargonithes*, which contains the *Accipitres*. This is the view which is held by the present writer, and in so far as our United States Owls are concerned I consider the suborder *Striges* is represented by the two families—(1) the *Strigidæ*, containing the single genus and species, *Strix pratincola*, and (2) the *Bubonidæ*, which holds all the others—some eleven genera with the many species enumerated above.

Mr. F. E. Beddard, in a very excellent little paper published not long ago in *The Ibis*, says upon this point that

"the most obvious characters which distinguish the skull of *Strix* from that of the remaining genera have been pointed out by Milne-Edwards;[1] they are, firstly, the greatly elongated and narrow form of the skull in *Strix* contrasted with the wide short skull of other types; secondly, the relatively great thickness of the bones which make up the interorbital septum in *Strix* as compared with the extremely thin interorbital septum of other Owls.

[1] *Nouv. Arch.*, etc., p. 189.

"I find by a series of measurements of the skulls of the following types—

Strix flammea	*Bubo bengalensis*
Strix sp?	*Syrnium indrani*
Asio mexicanus	*Syrnium woodfordi*
Speotyto cunicularia	*Ketupa javanica*
Athene noctua	*Sceloglaux albifacies*
Bubo maximus	*Nyctea nivea*

that while *Strix* has the narrowest skull (the proportion of the greatest breadth to length being in *Strix* sp. inc. as 37.5 : 62, in *Strix flammea* 36 : 56), the other genera show a progressive widening of the skull; this culminates in *Speotyto cunicularia*, where the breadth is to the length as 37 : 38. I do not give the exact measurements in the other species mentioned in the present list, for the reason that such a table of measurements would only be of value if it embraced the results of a study of a larger number of species and of individuals. I may state, however, that I have examined a large number of Owls' skulls in the British Museum Collection, including those of two other species of *Strix* (viz., *S. perlata* and *S. delicatula*), and in no case do I find so long and narrow a skull as in the genus *Strix*. It may be worth while mentioning that *Sceloglaux albifacies* has a skull which comes nearer to that of *Strix* in its relative proportions than do the skulls of many other genera. The reason which leads me to lay some stress upon this fact is the opinion of Prof. Newton[1] that this curious Owl may prove to be intermediate between the *Strigidæ* and other Owls. I hope, however, to be able, at some future time, to compare the skeleton of *Sceloglaux* with that of *Strix*.

"Prof. Milne-Edwards, in his memoir upon *Photodilus*, shows plainly that this genus belongs to the Bubonine and not to the Strigine group in the proportions of the skull and in the possession of a flattened interorbital septum.

"There is one feature in the skull of the Striges, serving to distinguish the *Strigidæ* from the *Bubonidæ*, which has apparently escaped the attention of Prof. Milne-Edwards. In *Strix*[2] the prefontal processes of the ethmoid are rounded and much swollen. In *Bubo* and in all other genera of Owls which I have had the opportunity of studying the same processes are thin, leaf-like expansions, as they are in the *Accipitres diurnæ*. With regard to the other points of difference in the skull, I must refer the reader to Prof. Milne-Edwards' memoir." . . . .

[1] *Encycl. Brit.*, art. "Owl."

[2] Mr. Beddard gives very excellent figures in this paper of the basal views of the skulls of *Strix flammea* and *Bubo bengalensis*, but I have not reproduced these, and the reader can find the points referred to in other figures illustrating the present memoir and two views of the skull of *Strix* in the Plates.

Of the bones of the foot, Mr. Beddard also says that

"a comparison of the relative length of the phalanges of the third digit appears to afford another character for the discrimination of the *Striginæ* and *Buboninæ*.

"In *Strix* (Fig. 1) the first phalanx of that digit is markedly shorter than the second phalanx. In *Bubo* (Fig. 2) and in the other genera the two phalanges in question are subequal." . . . .

According to Beddard, in the paper we have been quoting,

"the principal osteological characters of the genus *Strix*, and which apparently distinguish it from all others, are the following:

(1) The skull is relatively long and narrow.

(2) The palatines are straight, nearly parallel to each other; they are of approximately the same width throughout; they almost conceal the underlying maxillo-palatines, which are broader from above downward than from side to side.

(3) The prefrontal processes of the ethmoid are rounded bones of some width.

(4) The interorbital region of the skull does not form a thin plate anteriorly, but is of considerable width from side to side.

(5) The sternum has but one notch on either side.

(6) In the foot the second joint of the third toe is considerably longer than the basal joint.

(7) There is no bony ridge upon the tarso-metatarsus.

"On the other hand, in the Bubonidæ the skeleton has the following characters:

(1) The skull is relatively broad and short.

(2) The palatines are curved, the hinder part of the bone being much wider than the anterior region; the maxillo-palatines are very broad from side to side.

(3) The prefrontal process of the ethmoid is a thin plate.[1]

(4) The interorbital plate is thin and often fenestrated.

(5) The sternum has two notches on either side.

(6) In the foot the second joint of the third digit is subequal in size to the basal joint.

(7) There is a bony ridge upon the under surface of the upper end of the tarso-metatarsus."

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[1] In *Athene noctua* and *Speotyto cunicularia* these processes are very small and are hidden by the palatines when the skull is viewed from the ventral surface. The skull is broader in these two genera than in any others examined by me, and the maxillo-palatines are smaller.

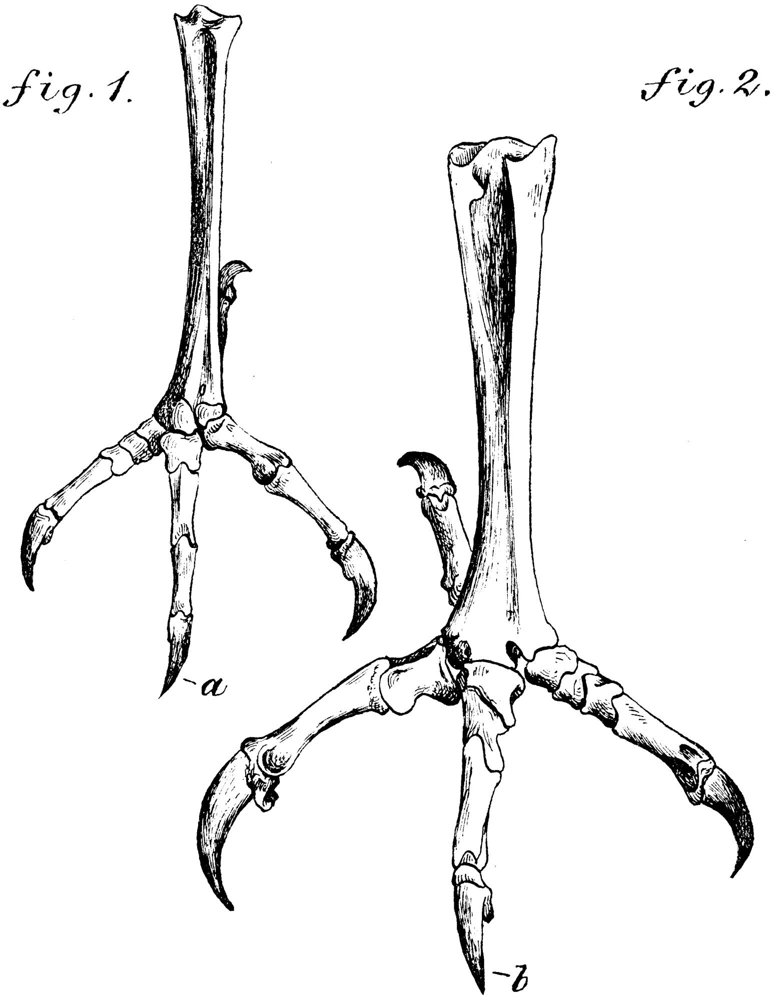

Fig. 1. Right foot of *Strix flammea* (nat. size). Fig. 2. Left foot of *Bubo bengalensis* (nat. size).

Both figures are sketches by the author from Beddard's figures, and the one of *B. bengalensis* will answer very well for any representative of that genus, as *B. virginianus*. *a* and *b* direct attention to the third digit where the subequality of the basal phalanges is seen.

Mr. Beddard found these differences supported in the two Strigine families in question by the dissimilarities that were exhibited on the part of the tensores patagii and the syringes. He presents very good figures of these last-mentioned structures as they occur in *Strix flammea*, *Bubo maculosus* and *Scops leucotis*.

Upon examining a skeleton (No. 18196) of our own American Barn Owl (*Strix pratincola*) in the collections of the United States National Museum, as well as the trunk skeleton of one in my private cabinets, I find that there are a number of good characters, referable to the osseous system of this bird, which are not noted by Mr. Beddard in the list of characters I have quoted from him above (see Pl. XIV, Fig. 21, and Pl. XV, Figs. 24 and 25). And as these characters are quite distinctive when we come to compare the skeleton of this Owl with a skeleton of any of the typical *Bubonidæ*, I will enumerate them here:

(1) The vomer is notably large in *Strix pratincola*.

(2) And in it, comparatively, the lacrymal is a very large bone and has considerable antero-posterior length.

(3) The manubrium on the sternum is aborted.

(4) The mid-lower point of the os furcula makes a pseudo-articulation with the anterior carinal angle of the sternum. It has been said that in very old Owls of this species anchylosis may take place at this point.

(5) The antero-lateral angles of the ilia are produced forward as prominent processes.

(6) An os prominens is not developed at the distal end of the radius.

(7) The head or proximal end of the tarso-metatarsus is twice perforated in the antero-posterior direction.

(8) Two vacuities are seen in the expanded portion of the proximal phalanx of the index digit.

This last-mentioned character reminds one of what we likewise find in some of the American *Caprimulgi*.

Agreeing with other Owls, we find in *Strix pratincola* nineteen free vertebræ between skull and pelvis, and eight in the skeleton of the tail, which count includes the pygostyle.

In the arrangement of the ribs we find them to vary; a specimen of *Stix pratincola* before me has a tiny pair of free ribs on the thirteenth vertebræ; they are larger on the fourteenth; while on the fifteenth the rib does not join with the sternum on the left side, but

does so by a costal rib on the right. None of the ribs thus far mentioned bear epipleural appendages. Now, in a specimen of *Asio wilsonianus*, the first pair of tiny free ribs occur upon the twelfth cervical vertebra; the next pair are considerably larger, while those on the fourteenth have epipleural appendages, and both connect with the sternum.

Strix pratincola also often has a pair of "floating ribs" behind the last dorsal pair. In this Owl, too, we find a very large patella. All Owls have a notably long fibula, while in *Strix* it is quite perfect and comes down very close to the condyle of the tibio-tarsus. The relative lengths of the bones of the lower extremity are rather remarkable in *Strix pratincola*. In a mounted skeleton (18196) in the cases of the United States National Museum of this species, I find the femur to measure 6.5 centimetres, the tibio-tarsus 11 centimetres, and the tarso-metatarsus 7.9 centimetres.

As is now well known, a variety of species of Owls have asymmetrical skulls, an asymmetry that is due largely to a distortion of the postfrontal and squamosal regions of the cranium. It may occur, I believe, upon either side. *Bubo virginianus*, however, presents us with no such character in its skull, and this Owl possesses a lofty superior osseous mandible, with the nasal septum completed in bone, all to a small space behind. In it, as in most Owls, the lower part of the great spongy lacrymal is moulded upon the still larger maxillo-palatine beneath; the last also being a tuberous, spongy mass, of a form something like a small chestnut, with the bulbous end to the rear. These maxillo-palatines do not meet each other mesially, and they rest, on either side, upon the horizontal prepalatine blade of the palatine bone (see Plate XII, Fig. 10).

In the lacrymal region a large foramen exists externally, the walls of which are formed chiefly by the lacrymal, the nasal and the maxillo-palatine. It passes into the rhinal chamber. As Mr. Beddard has already pointed out, the pars plana in all of the Bubonidine type of Owls is comparatively small and of a thin, plate-like structure. It is quite small in *Bubo virginianus*, and in all of the Owls wherein it exists, as we have just described it, it is so turned as to form a partial rest for the eye anteriorly, rather than an osseous partition between orbit and rhinal space beyond.

A very small vacuity may exist in the interorbital septum in *Bubo* and some strigine forms related to that genus, but it is of by no means a common occurrence.

All of the Owls I have ever examined possess basipterygoid processes, and I have often wondered what species of these birds Sir Richard Owen referred to when he wrote that they were absent in Owls (see *Anat. Verts.*, Vol. ii., p. 49).

On the superior aspect of the skull, such Owls as *Bubo* are narrow in the frontal region between the margins of the orbits, and the fronto-orbital processes are short and stumpy.

Another thing to be noticed in these large Owls is the prominent manner in which the frontal region of the skull overreaches the naso-premaxillary region in front of it. The frontal bones really bulge forward here, creating a very striking feature, totally absent in such a species as *Strix pratincola*, and only moderately well developed in some other Owls. The Owl's skull that shows it the best of all the specimens before me is one from *Bubo maximus*, a Japanese species, but it is by no means slightly marked in our own *Bubo virginianus* (see Fig. 4).

fig. 3.

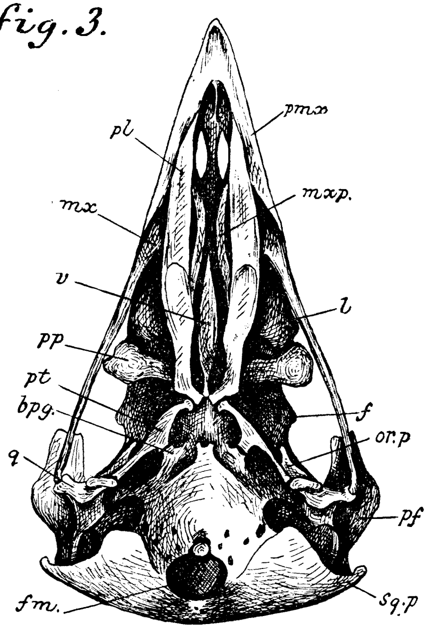

FIG. 3. Basal view of the skull of *Strix pratincola* (No. 18196, U. S. Nat. Museum). Adult; life-size.

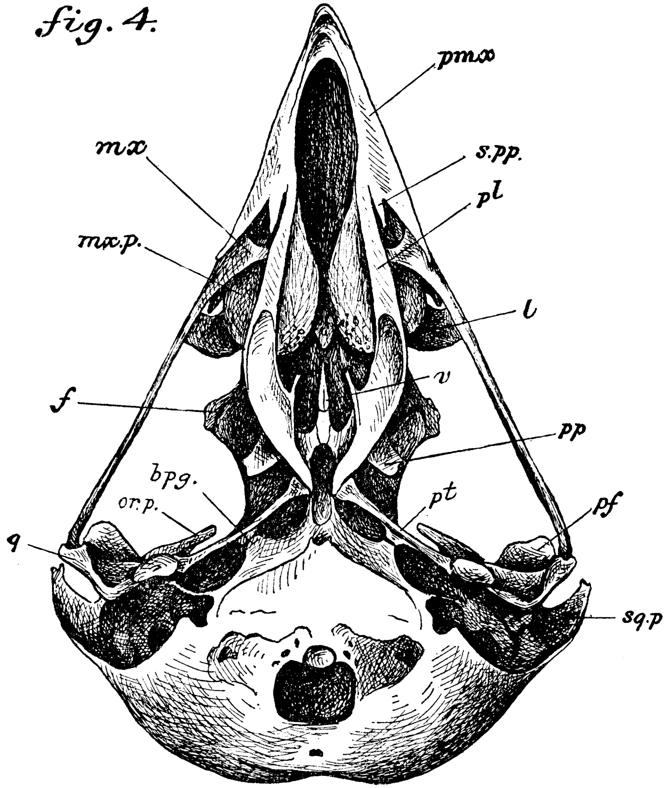

FIG. 4. Basal view of the skull of *Bubo maximus* (Japan) (No. 18227, U. S. Nat. Museum). *pmx.*, premaxillary; *mx.*, maxillary; *pl.*, palatine; *mx.p.*, maxillo-palatine; *s.pp.*, secondary palatine process; *l.*, lacrymal; *f.*, frontal; *v.*, vomer; *p.p.* pars plana; *pt.*, pterygoid; *b.pg.*, basipterygoid process; *pf.*, post-frontal; *sq.p.*, squamosal process; *q.*, quadate; *or.p.*, orbital process of quadrate; *fm.*, foramen magnum.

Turning to the mandible of this last-mentioned species, we find it to be of a broad V-shaped pattern, with rather a shallow symphysis; truncate angular ends, with large inturned processes there; moderately high ramal sides, and always exhibiting a long, irregularly-shaped ramal vacuity near the middle of the same. This ramal vacuity is small in *Strix pratincola.*

Passing to the trunk skeleton and the skeleton of the limbs, we have but little to add to what has already been pointed out in the foregoing paragraphs of this memoir. With respect to the pelvis,

it calls to one's mind the skeleton of many of the diurnal Raptores, more than any other single part in the osseous framework of the Owls is wont to do. Some of the *Accipitres*, however, possess interrupted post-pubic elements; I have never observed this to be the case in any American Owl. But aside from this character, the general facies of the pelvis, say of such a species as *Syrnium nebulosum*, or many others, reminds us very much indeed of the pelvis in certain species of Hawks.

This does not as a rule apply especially to the sternum, nor yet to the shoulder-girdle. As we have already shown, the sternum in all of the *Bubonidæ* is strongly two-notched upon either side behind.

The outside pair of notches are usually very deep in representatives of the genus *Syrnium*.

Returning to *Bubo virginianus*, we see that in the skeleton of the arm the humerus is the only pneumatic bone, and the long slender radius is interesting from the fact that it has the os prominens articulated with its distal extremity, and a peculiar little osseous arch is found upon the side of its shaft at the proximal third of its continuity (see Fig. 5, *os. p.* and *oa.*).

The ulna is about three times the calibre of the radius, with the distal moiety of its shaft nearly straight, while the proximal half is gently arched. Bones of manus are all well-developed, but withal present us with no very striking characters. The differences seen in the expanded part of the proximal phalanx of index digit, respecting *Strix* and *Bubo*, have already been pointed out above.

In the *pelvic limb* we find all the bones nonpneumatic, and the points of interest to be the great length of the fibula and the peculiar form assumed by the tarso-metatarsus.

The characters of the joints of the toes have already been commented upon above. With respect to the tarso-metatarsus, we again meet with a bone that agrees in some of its features with the corresponding part of the skeleton among some of the *Accipitres*. The hypotarsus is single, prominent and placed to the inner side of the shaft. Deeply and longitudinally excavated adown the entire posterior aspect of its shaft, it is only partially so in front, and that for the proximal half of the bone. A bony bridgelet spans the latter excavation just below the head of the bone and to its inner aspect. This is also seen in *Pandion* among the diurnal *Raptores*; and in that form, too, we note a very perfect fibula—that is, for an ornithic type. Some other Hawks are not backward in that particular.

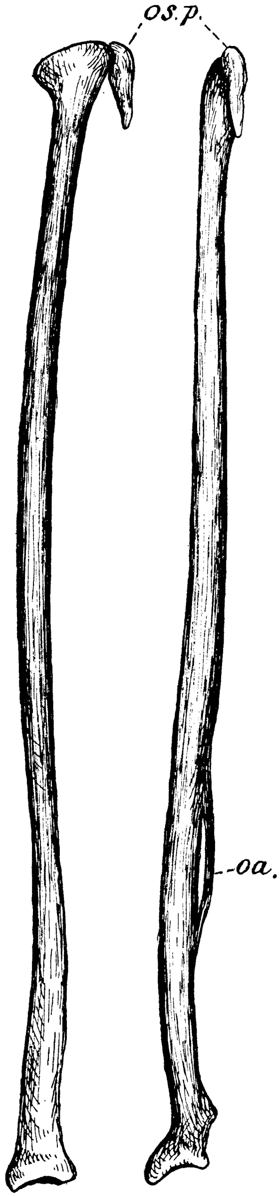

FIG. 5. Radius of an adult specimen of *Bubo virginianus;* drawn life-size. The bone on the left-hand side is seen upon superior aspect; the one on the right, upon anconal view. *os. p.*, os prominens; *oa.*, osseous arch.

The femur in *Strix pratincola* appears to be pneumatic. All Owls appear to be supplied with a large patella at the knee.

I shall now proceed to give a few selected extracts from my memoir on *Speotyto cunicularia hypogæa*, as I said I would do in the Introduction to the present memoir. A superficial examination of a skeleton of *Speotyto* is quite sufficient to convince us that its affinities are with the bubonine Owls rather than with the genus *Strix*. We will not then have to especially dwell upon this point.

Essentially, the characters of the skull and mandible of *Speotyto* are briefly as follows:

Owing to its delicate structure, it is a skull of extreme lightness; and as to form, its greatest width lacks but little of its being equal to its median longitudinal diameter. Vertically it is of moderate height, while the cranial vault externally is markedly smooth and rounded in the parietal and adjacent regions. The septum marium is complete, the external osseous nostrils being somewhat rounded ellipses in outline. Either lacrymal bone is free, and grooved upon its outer aspect for the lacrymal duct. Superiorly, we are to note in the frontal region that the skull is inclined to be narrow between the upper orbital margins; and the supraorbital processes, thrown outward and backward on either side by a frontal, are of spiculaform proportions. The thin interorbital plate or partition may, and usually does, show one small central vacuity in it. The nerve foramina are small and generally round in outline. Pars plana is meagrely developed, and presents the characters of the bubonine Owls generally. A quadrato-jugal bar is stout, and is peculiar in that upon its superior aspect, at the junction of middle and posterior thirds, it sends upward a transversely compressed triangular process, that also exists as a character in the skulls of *Surnia* and the Pygmy Owls among American species now at my hand. Postfrontal processes are broad and conspicuous, while a squamosal bone forms a great shell-like bulla that arches forward as a shield to the external auditory aperture. The antero-superior angle of this bulla, upon either side, fuses with the edge of the postfrontal at the orbital periphery, thus creating a small foramen there, which in the living bird transmits the tendon of the temporal muscle. The skull of *Speotyto* is symmetrical. Above the foramen magnum a well-marked supraoccipital eminence is seen, which is pierced mesially by a small and usually circular vacuity.

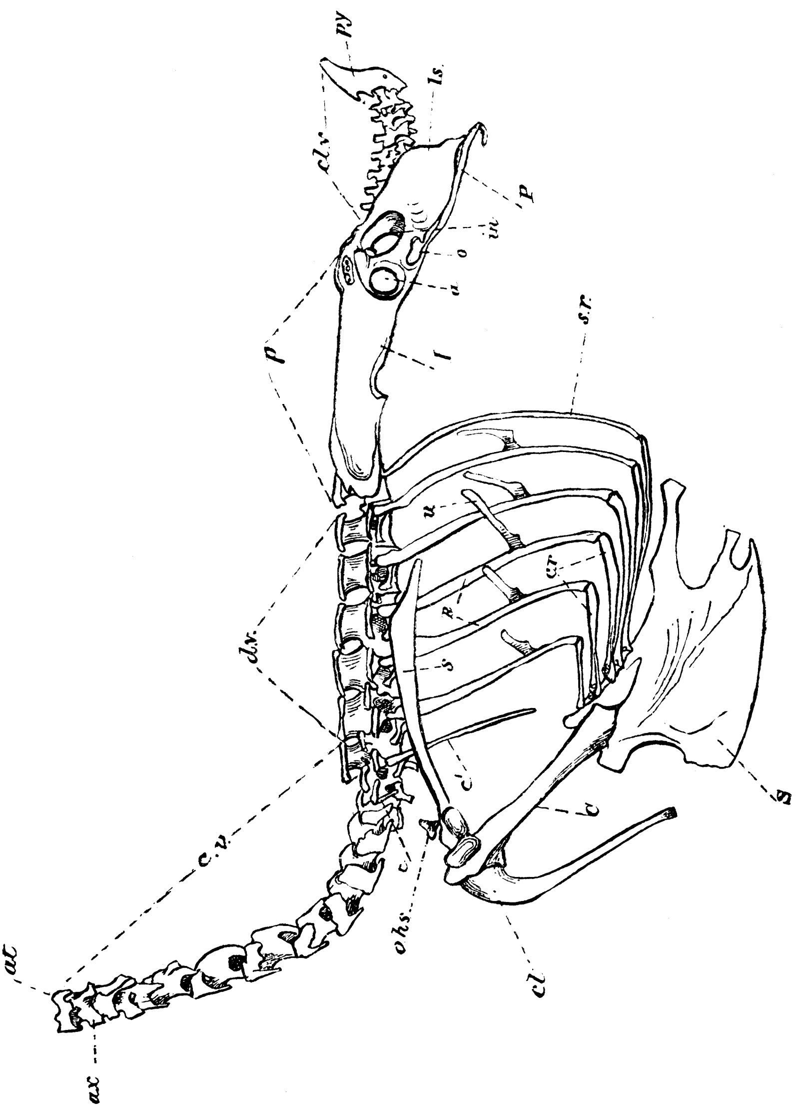

FIG. 6. Trunk skeleton, without the skull, of *Asio wilsonianus*. Adult; life-size. *at.*, atlas; *ax.*, axis; *cv.*, cervical vertebræ; *c*, *c'*, cervical ribs; *dv.*, dorsal vertebræ; *R*, two of the dorsal series of ribs; *s. r.*, sacral rib; *u.*, the unciform or epipleural appendage of the third dorsal rib; *c. r.*, costal or sternal ribs (hæmapophyses); *p.*, pelvis; *I.*, ilium; *Is.*, ischium; *P.*, pubis; *a.*, acetabulum; *in.*, ischio-iliac foramen; *o.*, obdurator foramen; *clv.*, caudal vertebræ; *py.*, pygostyle; *s.*, scapula; *ohs.*, os humero-scapulare; *cl.*, clavicle; *C.*, coracoid; *S.*, sternum. (This figure is a lettered scheme to Fig. 30, Plate XVII.)

As in almost all Owls, the mastoidal part of the quadrate is notably long; and the well-developed basipterygoidal processes are present for articulation with the pterygoids. Palatines are not very wide, and they are inclined to be bowed outward along their lengths. Maxillo-palatines, too, are comparatively small and well separated from each other in the median line. They are of the same spongy structure that we see in the *Striges* generally. I am inclined to think that the vomer never ossifies in *Speotyto*, and, as we know, it is very small in a number of other Owls.

This little Burrowing Owl possesses a mandible of a form common to most of its family. A large ramal vacuity is always present in it upon either side, and the bone is pneumatic.

Speotyto has its orbits of comparatively large size, and the sclerotal plates of the eye itself are strong and ample.

The hyoid arches are suspended from the base of the skull by their usual attachments. In this Owl they consist of six separate little bones, involving five articulations. The tips of the upturned posterior extremities are about opposite the lower borders of the temporal fossæ, its two limbs diverging from each other at an angle equal to that made by the lower mandible. The ceratohyals are rather large in comparison with other bones. They are joined both anteriorly and posteriorly by bony bridges, forming a fenestra between them to be filled in by a thin membrane. The amount of divergence they make from each other is less than that made by the epibranchial elements of the thyrohyals. Anteriorly the bone connecting them supports a cartilaginous glossohyal, while the posterior connection presents for examination the usual smooth articulating surface that enters into the arthrodial joint it makes with the basibranchial. The first basibranchial and second basibranchial are confluent, not a sign of the point of union remaining. The latter bone is continued a short distance posteriorly by a tip of cartilage. The anterior end of the first basibranchial is devoted to the articular surface for the bone connecting the ceratohyals, forming the joint mentioned above. It is concave from above downward, convex from side to side, the lower lip being the longer. It will be plainly seen that this combination grants to the tongue a movement in the vertical and horizontal planes. The anterior articulating heads of the epibranchial elements of the thyrohyals are opposite each other, each being received into the diminutive acetabulum intended for it at the side of the united first and second

basibranchials, and most probably at the junction of the two latter bones. These two elements are long bones having a cylindrical shaft, terminating at either end in an articulating head. They are the longest bones in the hyoidean apparatus, and have a gentle curvature upward throughout their extent. The inner heads form an arthrodial joint on either side with the outer heads of the cerato-branchial elements of the thyrohyals. These, the last bones of the arch, are joined in the manner already shown above. Their inner ends are quite pointed, even as far as the bone goes, the extreme points being finished off with cartilage. They curve upward from about their middle thirds, and, like the first elements of the thyrohyals, they are long bones, but with curved cylindrical shafts, the outer end, however, being the only true articulating one.

The Spinal Column: Cervical Portion.—There are in *Speotyto* fourteen cervical vertebræ, each one having a more or less free movement with the one beyond and behind it, the chain maintaining in all positions some variation of the usual sigmoid curve observable in this division of the vertebral column throughout the class. The arrangement, as well as the direction, of the planes of the zygapophysial articular surfaces allow considerable rotary movement and bending in the vertical plane, with combinations of the two. It is a common habit of this bird, among other of his antics, to duck his head smartly downward and again upward, several times in succession, upon being approached. The calibre, as well as shape, of the neural canal in this portion of the spinal column varies at different points. It originates at the atlas as a transverse ellipse, with a major axis of four millimetres and a minor axis of a little less than three millimetres; this is about the maximum capacity throughout the entire canal. From the atlas to the sixth or seventh vertebra the ellipse gradually approaches the circle, with a marked diminution in size, its diameter being at the seventh about two millimetres in any direction. From this point to the twelfth, inclusive, it rises as it fell from the atlas, and in the same manner, when we again discover a transverse ellipse, perhaps a jot smaller than the one described in speaking of the atlas. In the thirteenth the canal is smaller than, though in all other respects it resembles, the twelfth; but an abrupt change takes place in shape as we pass to the fourteenth or last cervical, where the form of the neural tube suddenly approximates the circularity of the dorsal vertebræ. The vertebral canal begins, circular, on either side at the

third cervical vertebra, most of its length being immediately beneath the prezygapophyses of each segment. It is formed in the usual manner by the di- and parapophysial processes uniting laterally with the pleurapophysial elements. Small at the cephalic extremity of the column, its calibre gradually increases in each vertebra as we proceed toward the thoracic extremity, until it attains its maximum capacity at the eleventh vertebra. In the twelfth the integrity of its walls is lost by a parting of the par- and pleurapophysial elements, with a disappearance of the former, leaving it no floor, so that in this vertebra it ceases to be a closed canal. The most prominent object presenting itself for examination in the atlas, superiorly, is the deep reniform cavity for articulation with the occipital condyle of the basi-cranii. Below and posteriorly there is another articulating surface, convex for the centrum of the axis and concave for its odontoid process, accurately meeting the opposed surface of this vertebra and forming the atlo-axoid articulation. A lip of bone, a portion of the hypapophysis of the vertebra we are now describing, projects downward and shields this joint in front, overlapping indeed a good part of the axis. The neurapophyses of the atlas are slight in structure. The concave postzygapophyses articulate with the convex prezygapophyses of the axis. The bone is devoid of a neural spine. In the axis we find both an hypapophysis and neural spine developed, the former being produced from the ridge on the anterior aspect of the centrum of the bone. The odontoid process arises vertically from the posterior margin of the upper surface of the centrum. Its summit and anterior face are convex and articulating, while behind it is flat and continuous with the spinal canal. The facet for articulation with the centrum of the third vertebra looks downward and inward, is convex from side to side and concave in the opposite direction. The postzygapophyses are concave, look downward and outward, the conditions in the prezygapophyses being exactly the opposite; this is the rule throughout the cervical portion of the column. After we pass the atlas and axis, we find in the third cervical vertebra here, as in most vertebrates, parts that are common to the series of this portion of the column, deviating but slightly from each other as we examine them *in seriatim;* but gradually as this deviation proceeds some requisite condition is brought about when the climax is attained. The fact of the presence of a neural spine on the axis is

conveyed, though in a less marked degree, to the third or next vertebra below, where it occupies a position about the middle of the bone. As we pass toward the dorsal region this process becomes less and less prominent, being found set farther back on each successive vertebra; it disappears about entirely at the tenth, after which it rapidly begins to make its appearance again, assuming its former position in the middle of the vertebra, being quite evident in the twelfth in the shape of a pointed spine, while in the fourteenth it has the quadrate form, with extended crest, much as we see it in the true dorsal vertebræ.

In the third vertebra the space between the pre- and postzygapophyses is almost entirely filled in, a minute foramen on either side alone remaining, by a lamina of bone extending from one process to the other, giving to this vertebra a much more solid appearance, which in reality it possesses above that attained by any of its fellows. This bony lamina is reduced in the fourth vertebra to a mere "interzygapophysial bar" connecting the processes, while in the next succeeding one or two vertebræ it occurs only on the prezygapophyses more as a tubercle, being directed backward, then disappearing entirely, to be found again only on a few of the last cervicals as an ill-defined knob, still retaining its original position. The diapophyses at first project nearly at right angles from their respective centra, then approach the median line by being directed more backward near the centre of the cervical division of the column, and on nearing the dorsals again gradually protrude more and more directly outward. The prezygapophyses of the ninth cervical support well-marked anapophysial tubercles, which are feebly developed also on a vertebra or two above and below the ninth. The joints between the bodies of the cervicals of this Owl are upon the same plan as those found throughout the class; the anterior facet being concave from side to side, convex from above downward, the reverse being the case with the posterior facets, and when articulated fitting accurately into each other. The pleurapophysial elements, well marked in all the cervicals after passing the axis, become in the thirteenth vertebra a free cervical rib, about three millimetres in length, without neck or true head, being merely suspended on either side from the diapophyses of the vertebra, and freely movable on its exceedingly minute articulating facet.

Attached to the last cervical we find the second pair of free ribs, about two-thirds as long as the first pair of dorsals or true ribs of

the thorax. These terminate in pointed extremities and articulate with the vertebra by both capitula and tubercula, the former on elliptical facets, placed vertically on either side of the centrum at the anterior margin of the neural canal, and the latter on rounded facets beneath the transverse processes. The tubercle on one of these ribs is nearly as long as the neck; at the junction on the posterior side is found a pneumatic foramen of considerable size. These ribs are more or less flattened above from before backward, being convex anteriorly, concave posteriorly, becoming rounded below. From third to ninth vertebra, inclusive, appear beneath the vertical canal anteriorly well-developed styliform parapophysial processes, directed backward and downward. They are best marked on the segments on the middle of the neck. There is no instance in this bird of these processes being produced so far backward as to touch the next vertebra below; their tips, as a rule, about overhanging the middle of the centrum of the vertebra to which they belong. We have found in specimens of *Bubo virginianus* the parapophyses of the fourth vertebra overlapping and touching the fifth for a millimetre or more. The third and fourth cervicals have, beneath in the median line posteriorly, strongly developed hypapophyses, quadrate in form, a process that exhibits itself anteriorly on the fifth vertebra merely as a small tubercle. On the sixth this tubercle has disappeared, and has been supplanted by two others that are now found just within the periphery of the anterior facet of the centrum beneath, and on the parapophysis of each side, they being inclined toward each other. These processes, now a double hypapophyses developed from the parapophyses, continue to increase in size and inclination toward each other on the next three vertebræ, so that on the ninth, where they last appear, they nearly form a closed canal. The passage between them is intended for the carotids, to which they afford protection. The hypapophysis of the tenth, eleventh and twelfth vertebræ is single, large, quadrate and directed forward and downward. There are three on each of the last two vertebræ, each having an independent root, the two lateral ones directed downward, forward and outward, with characteristics similar to the one in the median line. Several pneumatic and nutrient foramina perforate each cervical vertebra at various points, except in the axis and atlas, where, after diligent search, aided by the lens, we have signally failed to discover them.

Dorsal Vertebræ; Vertebral and Sternal Ribs; Sternum.—The

dorsal vertebræ number five; the anterior one articulates with the last cervical and the last dorsal with the first sacral. Although the dorsals of this bird fit very snugly to each other, it requires no further masceration to separate them from one another than it does to remove the ribs from their attachments. This close interlocking, however, greatly diminishes the movement of this division of the spinal column, bestowing upon it a rigidity only exceeded by the anchylosed vertebræ of the sacrum; yet, it must be understood, they do enjoy, in this Owl, a considerable degree of movement, especially laterally. The neural spines have here attained their maximum development, forming, when taken together, an elevated and compressed median crest, with a thickened summit, and having a firm hold upon the remainder of the vertebræ below. Taken separately, the last is the smallest, the fourth next, and the second and third the largest. Their anterior and posterior borders are concave, allowing, when articulated, spindle-shaped apertures to exist among them, while their summits are produced backward and forward, thickened and wedged into each other. This wedging is performed in the following manner: The posterior extremity of the crest forming the summit of the neural spine of the first dorsal divides and receives the anterior extremity of the crest of the second. This same arrangement exists between the second and third, and at the summit between the third and fourth, immediately below the junction, also divides for a little distance and receives the edge of the posterior rim of the third, just beneath the union of the crests. This latter method of joining is feebly attempted between the fourth and last. The neural canal is nearly cylindrical in the dorsal region, its calibre being less at the sacral extremity and rather compressed from side to side, as are the centra as we approach that end, each one being a little more so than its neighbor beyond. Viewing these five vertebræ from above in the articulated skeleton, we observe the spinous crest already described; we are struck with the regularity with which the postzygapophyses overlap and adjust themselves to the prezygapophyses from before backward, the facets of the former facing downward and outward, the opposed surfaces of the latter facing upward and inward. The transverse processes are horizontally compressed and rather broad; the neural spines jut from them at right angles from points about their middles. There is an inclination for the latter to be directed slightly backward as we near the sacrum. The diapophysis of the

first dorsal is the shortest and stoutest, that of the last the most delicately constructed. Superiorly, these processes support metapophysial ridges at their extreme outer borders. These ridges on the transverse processes of the first dorsal are the largest, being rounded at both ends, and extending a little backward and forward, but far from touching the ridge either in front or behind them. The metapophysials of the last dorsal are smaller, being sharp, styliform and project only forward, not touching, however, the transverse processes in front of them.

On the intermediate vertebræ they change gradually between these two extremes, but in no instance meet the transverse processes of the vertebra before or behind them, and thus constitute an additional aid to the rigidity of the back, as it does in other species of this family and in many other birds. The centra increase in depth beneath the neural canal the nearer they are to the sacrum. In the first dorsal the body measures about one millimetre, the vertical diameter of the canal being three; in the last dorsal it equals the diameter of the canal. The interarticular facets are in the vertical plane, with their concavities and convexities opposed to each other, as they were described when speaking of the last cervical vertebræ. The bodies are about of a length, constricted at their middles and expanding toward their extremities. The first two dorsals each bear in the median line, beneath, a hypapophysial process of considerable size, affording abundant surface for attachment of some of the muscles of the neck. The process of the first dorsal has one common trunk, with a compressed midprong and two lateral and pointed subprocesses. The second dorsal possesses a single long hypapophysis, quadrate in form, dipping into the chest further than the first. There is not a trace on the remaining dorsals of this appendix. Parapophysial processes, so prominent in nearly all the cervicals, afford in the dorsal vertebræ simply articulating facets for the capitula of the ribs situated just within the anterior margin ot the neural canal of each centrum, never extending to the vertebræ beyond, forming the demi-facet of andranatomia. Immediately above these facets, on either side, may be noticed a group of pneumatic foramina, of various sizes and shapes, and again, anterior to these foramina, the rim of the body of the vertebra for a limited distance becomes sharply concave, being opposite to a like concavity in the next vertebra, the two, when opposed and articulated, forming the oval foramen for the exit of the dorsal nerves.

Elliptical articulating facets for the tubercula of the ribs, looking downward and outward, are seen on the inferior ends of the transverse processes, with a midridge running from each facet to the base of the process, to be expanded and lost on the sides of the centra. As there are five dorsal vertebræ, so there are five dorsal ribs articulating with them and with the sternal ribs below. Each rib is attached to a single vertebra, as shown while speaking of the dorsals. The neck of these ribs become more elongated the nearer they are to the pelvic extremity of the body, the first possessing the shortest. This is exactly reversed in regard to the pedicles bearing the tubercula, being the longest in the first rib and shortest in the last. This contraction of the pedicles is progressively compensated for by the lengthening of the corresponding and respective transverse processes of the vertebra to which they belong. Viewing the ribs from the front, in the skeleton, the curve they present resembles the quadrant of a shortened ellipse, the vertex of the major axis being situated at the base of the neural spines; viewed laterally, the curve is sigmoidal, though a much elongated and shallow one, with the hæmapophysial extremity looking forward and the facet of the tubercle backward. The first rib is the shortest and generally, though not always, the broadest; the last being the longest and most slender, the intermediate ones regularly increasing in length and diminishing in breadth from the first to the last. In form, the ribs of this Owl are flattened from side to side, widest in the upper thirds, narrowest at their middles and club-shaped at their lower extremities, where they articulate with the sternal ribs by shallow facets. On the inner surfaces we find the necks produced upon the bodies as ridges, running near their anterior margins and becoming lost at about the junction of the upper and middle thirds in the body of the rib. Pneumatic foramina, from two to three in number and of considerable size, are found just within the commissure between neck and tubercle, posteriorly. All the vertebral ribs bear a movably articulated *epipleural appendage*, each resting in a shallow cavity designed for it upon the posterior borders. They leave the rib at right angles, but soon turn upward with a varying abruptness. The appendage of the first rib is situated lowest of any on its rib, that of the last the highest; the facets of the others are found in the line joining those of the first and last. They all make acute angles with the bodies of the ribs to which each belong, above their points of insertion. The angle made by the last is the least, and it

increases to the last. The epipleurals of the leading ribs are the widest and generally the longest. The one on the second rib in a skeleton of this bird now before me is as wide as the rib at the point from where it starts; the one on the last rib being always the smallest.

Clubbed at their superior extremities, each one overlaps the rib behind it, and in this manner adds stability to the thoracic parietes, which is undoubtedly the function these little scale-like bones were intended to fulfill. The sternal ribs connect the vertebral ribs with the sternum. There are six of them, one articulating with each vertebral rib, and having a concave facet to receive it, while the last meets the sacral rib above and articulates with the posterior border of the fifth below. The first one is the shortest and most slender of all; the fifth is the longest. With the exception of the last, their superior ends are enlarged and compressed from side to side, while below their middles they become smaller; then turning upon themselves, suddenly enlarge again, so as to be flattened from before backward, when each terminates by a transverse articular facet for articulation with the sternum. Quite an interspace exists between their facets of articulation. They all make a gentle curve upward just before meeting their respective ribs. The sternal rib that articulates with the sacral rib is inserted in a long, shallow groove on the posterior border of the sternal rib that articulates with the last dorsal one, but does not meet the sternum, simply terminating in a fine point on the posterior border of the sternal rib mentioned. From before backward the sternal ribs make a gradually decreasing obtuse angle with the vertebral ribs, while the angle they make with the sternum is a gradually increasing acute from the fifth to the first. On the anterior surfaces of their expanded sternal ends are to be found on each a minute pneumatic foramen or two. The anterior third of the lateral borders of the sternum is the space allotted for the insertion of these bones.

The Burrowing Owl being a bird not possessed of any considerable power of flight, or the necessity of having that flight ever long sustained, a circumstance arising from the life it has come to lead, we would naturally expect to find, in the course of a study of its anatomy, those characteristic modifications of the various systems which pertain to species of the class in which that gift has always been a secondary consideration. Nor are we disappointed in this expectation, for a glance at the size of the sternum of this Owl,

when compared with the remainder of its skeleton with regard to areas for muscular attachments, reveals to us the disproportion of the surface supplied by that bone for the attachment of the pectorals. That its dimensions are relatively contracted is proved by actual comparative and proportional measurements of the bones with other species of its family, individuals of which, at the best, are not noted for their powers of flight, as a rule, and of a consequence the sternum does not present so prominent a feature of the skeleton as it does in other species of the class *Aves* where vigorous flight is habitual. The concave dorsal aspect of the body is smooth, being traversed in the median line by a very shallow groove that lies immediately over the base of the keel. This groove terminates, within five millimetres of the anterior border, in a litttle depression, at the bottom of which are discovered pneumatic foramina, two or more in number, leading to the anterior vertical ridge of the carina beneath. Other minute openings for the admission of air into the interior of this bone are seen among some shallow depressions just within the costal borders. The bone does not seem to be as well supplied in this respect as it is in some other Owls. The costal borders supporting the transverse articular facets for articulation with the sternal ribs occupy anteriorly about one-third of the entire lateral border on either aide. At the bases of the majority of the depressions that occur between these facets are found other pneumatic foramina. The anterior border is smooth and rounded, with a median shallow concavity occupying its middle third. At its extremities, laterally, the costal processes arise with a general foward tendency at first, but with their superior moieties directed backward. The costal borders terminate at the posterior borders of these processes at a higher level than the anterior margin does at their anterior borders. The coracoid grooves are just below the anterior border. They are deep, continuous with each other, having a greater depth behind the manubrium in the median line than observed at any other point. Their general surface is smooth and polished, looking upward and forward, and lying principally in the horizontal plane. They melt away into the body of the bone laterally at points opposite and not far distant from the posterior articulations on the costal borders. The margin that bounds them below is sharp, travels at right angles from the median line, at first to a point posterior to the costal processes, then making a little dip downward, then again curving up-

ward, disappears gradually with the groove it bounds. That portion of it from the point where it changes its direction to its termination is described by authors as the subcostal ridge. The manubrium, occupying its usual position in the middle line, is comparatively small, quadrate in form, compressed below, slightly notched and flattened above, its posterior surface forming the inner anterior surface of the coracoidal groove. All the borders bounding the posterior parts of the bone are sharp; the lateral ones, taken from the apices of the costal processes to their other and lower terminations, are concave. As is the arrangement generally among Owls, the xiphoidal extremity of the sternum is four-notched, two on either side, the outer notches being the deeper. Both have rounded bases, and the processes that separate them are ample and possess rounded extremities. The border upon which the keel ends posteriorly is square, though we have met with specimens in which it was slightly notched in the median line. The body is oblong, and if we include the xiphoidal processes on either side, has a length half as long again as its width. The ventral and convex surface, like the dorsal, is smooth and presents but two points for examination. The pectoral ridge, faintly marked throughout its extent, originates on each side at a point near the outer borders of the coracoid grooves, running inward and backward, and dies away at the base of the keel near its middle. This little ridge denotes the line between the pectoralis major and minor. The keel is moderately well developed, the distance from the base of the manubrium to the carinal angle being equal to the distance from the same point at the base of the manubrium to the base of either costal process or outer anterior sternal angle. It is compressed, smooth and thin, but its stability is greatly aided by the carinal ridge on either side, which commences strong and well-marked at the base of the manubrium, just within the anterior border, running parallel with the latter, and disappears as it approaches the carinal angle. The anterior border of the keel is sharp and concave; the inferior border is convex, with the edge slightly thickened. The point of intersection of these two borders anteriorly is rounded and forms the carinal angle. The inferior border expands posteriorly, and the keel terminating a short distance before arriving at the posterior sternal border, the two become blended with the surface of the body of the bone.

Sacral Vertebræ and Coccygeal Vertebræ.—In the sacrum of the

Owl now under consideration, with the exception of a few faint lines indicating the original individuality of the vertebræ, these bones are thoroughly anchylosed together and to the ossa innominata. From inspection of this compound bone in immature birds we find the usual number of sacral vertebræ composing the sacrum to be thirteen. The anterior face of the first possesses all the necessary elements for articulation with the last dorsal. The neural spine has a thickened crest that soon meets the ilia on either side; its anterior edge is thin, and gives attachment below to the interspinous ligament. The neural canal is circular and the prezygapophyses well marked. The articular facet of the centrum is in the vertical plane, with its curvatures similar to those ascribed to the anterior facet on the centra of the dorsals. The neural spines are broad and the transverse processes are strong and raised, with their enlarged extremities expanded upon and firmly united with the iliac bones. There is but one pair of sacral ribs, and they are free ones. Long and slender, they articulate with the first vertebra in the usual manner, but the relation is much more intimate, as they touch the diapophyses for some little distance beyond the tubercula toward the capitula. The lower extremities of these ribs are terminated by little roundish knobs, which articulate with the corresponding sternal rib on either side, described above as being inserted in the posterior border of the fifth sternal rib. Viewing the bone dorsal-wise, it is to be seen that the thickened crest of the neural spine of the first vertebra protrudes from the angle made by the ilia meeting it anteriorly to a greater or less distance. This broad and compressed crest, then continued backward, is firmly wedged between the ilia until we pass the third vertebra; at this point the ilia diverge from each other to another point just anterior to the acetabula, then converge, terminating in the posterior sacro-iliac border, within five or six millimetres of each other. The sacrum completely fills in the lozenge-shaped space thus formed from the third vertebra—first, by continued broadening and compression of the neural spine, that soon becomes one with the others of the series; and secondly, by the expanded extremities of the di- and parapophyses, the processes themselves also taking due part. The integrity of the surface is unbroken, save posteriorly, where a few pairs of foramina exist among the expanded transverse processes, increasing in size from before backward. Anterior to a line joining the acetabula the surface is in the

horizontal plane; posterior to this line there is a decline, which declination is accepted also by the innominate bones; this gives the entire pelvis a shape that seems to be characteristic of a majority of both the diurnal and nocturnal *Raptores*. The "ilio-neural" canals here present open but small apertures posteriorly at about the point where the ilia commence to diverge, passing obliquely downward and forward; their anterior openings are large enough to allow a view of their internal walls. The neural spine that divides them throughout is compressed from side to side; the ilia which form their outer boundaries are convex; the neuro-spinal crest forms the roof, the basal surface being deficient, formed merely by the spine-like di- and parapophyses of the vertebræ and the confluent neural arches. Now, a line drawn mesially on the centra below, from the first centrum to the last, gradually rises until opposite the anterior borders of the ischiadic foramina, then curves rather abruptly downward to its termination. The centra of the first two or three vertebræ are compressed from side to side to such an extent as to cause them to appear wedge-shaped, the common apex or edge being below; after that, however, they rapidly broaden, become compressed vertically and more cellular in structure. They are very broad from the fourth to the ninth, inclusive, then as rapidly become contracted as they approach the coccyx. Minute but numerous pneumatic foramina are seen at or near the usual localities. The largest foramina for the exit of the roots of any pair of sacral nerves is generally in the fifth vertebra; they decrease in size as they leave them either way. In the young only the last few of these foramina are double; they are all double in the adult, and placed one above another, a pair on the side of each centrum at their posterior borders. The tranverse processes of the anterior five sacral vertebræ are thrown out against the internal surfaces of the ilia, to which they are firmly attached, and act as braces to hold the engaged bones together. The parapophyses of the first form facets for articulation with the sacral ribs; the second and third have none; in the fourth and fifth they also act as braces in the manner above described, joining the ilia just before their divergence commences. Reliance seems to have been placed entirely in the completeness of the sacro-iliac union in the last vertebræ, for the apophysial struts terminate in that portion of the pelvic vault formed by the sacrum itself, except in the last two vertebræ, where the parapophyses abut against the iliac borders. The

parapophyses of that vertebra which is opposite the acetabula are prominent, they being long and ample, reaching to the border and reinforcing that part of the pelvis that requires it the most, the vicinity of the leverage for the pelvic limbs. In other *Strigidæ* several apophyses are thrown out at this point. The posterior opening of the neural canal in the last sacral vertebra is subcircular, its diameter being about a millimetre in length. This vertebra also possesses small postzygapophyses, looking upward and outward for articulation with the prezygapophyses of the first coccygeal vertebra; the articulating facet of the centrum is also small, long transversely, notched in the median line, the surface on either side being convex. At every point where the sacrum meets the iliac bones union is firm and complete, though both upon the internal and external surfaces the sutural traces are permanently apparent. The anterior iliac margins, as they diverge from the sacral spine, form an acute angle, concave forward; they have a well-marked rim or border, nearly a millimetre in width, raised above the general surface of the bone, which disappears on the outer borders as we follow them backward. The two anterior and outer angles overhang the sacral pair of ribs and fifth or last dorsal pair. From these last the marginal boundaries, which necessarily give the bones their form, are produced backward and outward to a point opposite the centrum of the third sacral vertebra, then backward and inward, forming at the above points two lateral angles. From the apices of the two lateral angles to where the borders terminate on either side in front of the acetabula with the pubic bones, the direction is such as to form a concavity on each side; the line adjoining the bases of these concavities, points opposite the posterior openings of the ilio-neural canals, being the narrowest part of the pelvis. The upper and at the same time the inner margins of the bones in question form the anterior and median angle at first approach, soon to diverge from each other and form the gluteal ridges and borders of those scale-like projections of the posterior portion of the ilia that overhangs the acetabula. Produced now as the "gluteal ridges," they tend almost directly backward, though very slightly inward, to terminate in the ischial margins. The preacetabular dorsal iliac surfaces are generally concave, while the postacetabular, and at the same time that surface which occupies the higher plane, is flat, having a slope downward and backward, with a ventral reduplication after forming the rounded and concave posterior

boundary of the pelvis. The preacetabular superficial iliac area is nearly double the extent of the postacetabular. The antitrochanterian facets that surmount the cotyloid cavities have the usual backward direction, though their surfaces look downward, outward and a little forward. The external surfaces of the ischia look upward and outward, having just the reverse direction ventrally. Posteriorly these bones are produced beyond the ilia into finely-pointed extremities, tending to approach each other. The slender pubic bones, after closing in the obdurator foramen on either side, touch and unite with the inferior borders of the ischia as far as the pointed ends of the latter, beyond which they are produced nearly to meet behind. The circular and thoroughly perforated acetabula are formed in the usual manner by the three pelvic bones. They have a diameter of about three millimetres, and their circumferences are in the vertical plane. The ischiadic foramina are elliptical and large; they are, as usual, posterior to the acetabular and above the obdurator foramina. These last are also elliptical and about one-third the size of the others. Viewing the pelvis ventralwise, we observe, in addition to points mentioned when speaking of the sacrum, the reduplication of the ilia, forming pockets behind and internally, that open outward through the ischiadic foramina and inward into the general pelvic cavity. The narrowest part of the pelvis measures 1.2 centimetres, the widest 2 centimetres, being taken between the iliac projections over the acetabula; the average length, including anterior neural spine, is 3 centimetres. Pneumatic foramina occur in the shallow anfractuosities, between the antitrochanters and gluteal ridges in the ilia. None of the caudal vertebræ are grasped by the pelvis, the posterior extremity of the sacrum always assisting to form the posterior pelvic border. The usual number of these vertebræ is seven, though occasionally an additional one is found, making eight in some individuals. This enumeration does not include the modified and ultimate coccygeal vertebra, the pygostyle. They are all freely movable upon one another, and the first upon the last sacral vertebra. The articular facets upon the centra vary in shape throughout the series; that upon the first is long transversely, with a double convexity so arranged as to accommodate itself to the one on the extremity of the sacrum; they soon become uniform, to pass to the subcircular one existing between the last vertebra and the pygostyle, on which it is concave.

The pleurapophyses and parapophyses are very rudimentary or entirely suppressed. Each vertebra bears a prominent neural spine, which, from the first to the sixth, inclusive, is bifurcated; in the last two it appears as a mere primitive knobule. The transverse processes are all deflected downward and outward, very small in the first and still more so in the last; are largest in the fifth and sixth. Prezygapophyses are well marked; they reach forward and articulate with the feebly developed postzygapophyses. In a few of the posterior segments there appears to be an effort on the part of the neurapophyses to overlap the vertebra next beyond them. The neural canal is pervious throughout, commencing in the first with a calibre equal to that in the end of the sacrum; it gradually diminishes and terminates in a minute, blind conical socket in the pygostyle. Hypapophyses are produced downward in a few of the ultimate vertebræ. They hook forward and articulate with the centrum of the vertebra next beyond them. Sometimes they are observed to be free, or rather resting upon a facette on the anterior margin of one centrum and extending over to the anterior margin of the centrum of the vertebra anterior to it, to meet a similar facette, as a tiny styliform process. The spinal column is completed posteriorly by the pygostyle—that ploughshare-shaped segment that articulates with the last coccygeal vertebra. Above its cup-shaped facet this bone arises as a laterally compressed plate, extending backward and bifurcated at its extremity, as if to imitate the neural spines of the vertebræ of the series of which it is an ultimate appendage. Below the facet it projects forward and completes the median sequence of hypapophyses of the centra, being rather larger than any of them. The posterior curve is simply inflected downward and forward from its apex.

The Scapular Arch.—The three elements that constitute this arch are all represented, and all independent or free bones; the coracoids articulate with the sternum and scapulæ; coracoids and clavicle, connected by ligaments, lend their share to form or strengthen the shoulder-joints. The coracoid, comparatively large and strong, forms in the usual manner an arthrodial joint of restricted movement with the sternum, its lower end being in the coracoid groove on the anterior part of that bone. The inner angle of its base is about two millimetres from the mesial line, and four millimetres intervening between it and its fellow of the opposite side in the groove. This extremity is broad, its outer angle

being beneath the third sternal rib at its point of meeting the costal border; it is compressed from before backward. The articular facet, looking downward, backward and a little inward, is transversely concave, with a slight dividing ridge running anteroposteriorly, converting the general concavity into two smaller ones. The coracoid, when in position, is produced upward, forward and outward, making, with the vertical line through its base, rather an acute angle. A limited portion of the middle third of the bone only is subelliptical on section and at all shaft-like, due to the fact that the coracoid in this bird being perhaps less than the average length as compared with the size of the bird, and, secondly, to the unusually enlarged extremities, features observable, more or less, in *Raptores* generally. The anterior groove of the upper extremity, that is arched over by the head of the clavicle above, is deep and occupies fully the upper third of the bone. The coraco-clavicular process springs, thin and compressed, from the inner side of the shaft of the bone, at junction of upper and middle thirds, to turn upon itself, so as to be projected upward, forward and a little outward, terminating with an elliptical facet for articulation with the clavicle. The upper border of this process is concave lengthwise and articulates throughout its extent with the inferior margin of the acromial process of the scapula. The lower and thin edge of the coraco-clavicular process tends obliquely downward, to be lost on the inner surface of the shaft of the bone near its middle. The outer wall of the anterior groove is formed by the coracoid itself, the process just described being really nothing more than a wing-like extension forming the inner boundary of the groove in this bird; it terminates above both clavicle and scapula in a rounded tuberous head. Below this head, anteriorly and still more inwardly, the coracoid affords a vertical, elongated facet for the clavicle, while behind, looking a little outward, is the concave elliptical facet that constitutes about one-third of the glenoid cavity for the humerus. Internal to this last, and running first directly upward, then making a right angle and continuing forward, a little upward and outward, the last direction being the upper margin of the coraco-clavicular process, is another facet, for the scapula. Behind and below, this bone displays one or two lines and depressions, boundaries of muscular attachments. In the middle of the anterior groove, opposite the base of the coraco-clavicular process, the

shaft of the bone is perforated; this perforation is elliptical lengthwise with the shaft and passes directly through to make its appearance on the posterior convex surface just below the scapula. This foramen transmits a branch of that cervical nerve coming from between the twelfth and thirteenth cervical vertebræ. This nerve branch, after passing through the bone, is distributed to the under surface of the pectoralis minor muscle, and its filaments ascend among its fibers. This foramen is observable also in other Owls, as *Bubo virginianus*, and in some of the diurnal *Raptores*, as in *Accipiter cooperi;* in very many birds it is absent. This scapula presents little that is unusual in that bone among the class generally. It lends the additional two-thirds of articular surface to form the glenoid cavity with the coracoid; internal to this the acromion process extends forward, touching the coracoid as described and having a limited bearing on the clavicle. Posteriorly its blade-like length is produced, expanding, turning slightly outward, to terminate in an obliquely truncate extremity, with its point over the second dorso-pleurapophysial interspace.

What the scapula lacks in interest is amply made up by the changes observed in the last bone of the group, the clavicle. This element is broad above, much compressed from side to side throughout; it spans the anterior groove and touches the scapula as described above, rapidly diminishing in size as it is produced downward and inward by a gentle curve toward the fellow of the opposite side. The upper extremities in adult birds are separated by an average distance of 2.3 centimetres. If the sternum pointed to feebleness of flight in this little Owl, it is still further carried out by the ill-developed clavicles, which constitute that arch in birds when they are thoroughly and firmly united below, that assists to resist the pressure of the humeri when the wings are depressed in flight, and send them back to their former position after the completion of the action. In an old male *Speotyto*, we find this bone to be simply a pointed styliform process. In other individuals, however, and adults, too, the clavicle does not even attain to the length there shown; but, as if to bid defiance to any invariable rule governing its development, we again find in very young birds cases where it becomes confluent with its fellow, forming a broad U-shaped arch, though never a very strong one. In a case of this kind the bone was finely cancellous throughout, with an extremely attenuated layer of compact tissue outside, scarcely covering it.

In the figures given in my memoir on *Speotyto* and other individuals like it, the clavicles were pneumatic. Again, in both young and old, it may have any of its lower parts completed by cartilage; it never displays a mesial expansion of bone at the point of confluence. As already shown, the superior entrance of the anterior groove on the coracoid is a complete circuit, formed by the three bones of the group. The head of the coracoid overhangs it above; next below is the clavicle, closing it in anteriorly; lowest of all the scapula behind. A plane passing through the superior margins of this aperture would look upward, inward and backward. All the bones of the scapular arch are pneumatic, with the exception sometimes seen in the clavicle; and the foramina, to allow the air to enter their interiors, look into the enclosed groove of the coracoid just described. In the scapula the foramen is usually single and in the acromion process; single again in the clavicle, it is seen in the broadest part of the head, while in the coracoid there is generally a group of these little apertures, situated in the depression on the surface that overhangs this entrance to the coracoidal groove.

As in many others of the family, in common, too, with not a few of the diurnal *Raptores*, this Owl possesses an os humero scapulare, of the usual form, that increases the articular surface of the shoulder-joint for the humerus.

Of the Upper Extremity.—The upper extremity consists of ten distinct bones in the full-grown bird, omitting minute sesamoids that may possibly exist. These are the humerus of the arm, the radius and ulna of the forearm, two free carpels, the metacarpal and four phalanges. The humerus is a long, extremely light and smooth bone, and when viewed from above in its position of rest, with the wing closed, it reminds one of the curve in the small italic letter *f*, being concave above toward the scapula. And this bone is so twisted that this same curve is exhibited, though not quite as well marked, when viewing it laterally. The humerus is 5.5 centimetres long, subcylindrical on section at midshaft, at which point a minute aperture exists for the passage of the nutrient vessels that are distributed to the osseous tissue and its internal lining. This foramen enters the bone very obliquely, its external orifice being nearest the proximal extremity. This end is well expanded, and surmounted above by a strongly developed radial crest that overhangs the shaft slightly toward the palmar aspect. It occupies a

line on the bone from the articular facet for the shoulder-joint to a point one-third down the shaft. The ulnar crest, or lesser tuberosity, encloses quite an extensive fossa below, which acts also as a partial screen to the pneumatic foramina, for the humerus is highly pneumatic. These foramina usually consist of one circular opening, surrounded by a group of many smaller ones. In young birds a very large foramen is generally present; this closes in as age advances. Between the two tuberosities is the vertical and elliptical convex facet for articulation with the glenoid cavity of the shoulder-joint, constituting the "head of the humerus." The radial crest displays palmad, a ridge for the insertion of the tendon of the pectoralis major. The distal end of the humerus is also expanded in the vertical plane and gently convex anconad—the reverse condition of the proximal extremity. It presents for examination the articular facets for the ginglymoid joint it forms with radius and ulna and the superior and inferior condyles. The larger, and at the same time the superior, of these two facets is intended for the cup-shaped depression in the head of the radius, as well as a portion of the articular surface on the ulna. It is ovoid in form, and placed obliquely on the bone, the inferior end of the long axis of the oval being situated the nearer the proximal extremity of the shaft. This facet is separated from the trochlea surface for the ulna by a well-marked depression; this latter is a knoblike tubercle when compared with the radial facet. The condyles and the entire articular surface are about in the same plane posteriorly—that is, neither increases the length of the bone one more than another. Passing from the trochlea surface for the ulna toward the inner aspect of the shaft, there is to be observed a shallow depression, which corresponds to the olecranon fossa of human osteology, and in full extension of the limb allows room for that process of the ulna in this bird. The radius has an average length of 6.6 centimetres, and the ulna a corresponding length of 6.8 centimetres, so that their distal extremities when articulated, as we examine them in the closed wing, extend beyond the head of the humerus. In this position also the radius occupies a higher level than the ulna, and is the innermost bone of the two. The radius is slender, the transverse diameters of its subcylindrical shaft varying but little throughout its extent, though its extremities are expanded. From the elbow-joint, when the two bones are in position, it at first diverges from the ulna at a moderate curve, to

approach that bone again to nearly absolute contact at the junction of middle and distal thirds by a more gentle curve; from this latter point it lies parallel with the ulna to the wrist. The head of the radius is elliptical, being crowned by a depression for articulation with the oblique facet on the distal end of the humerus. Beyond, below, and to the outer aspect of this facet is another of similar form, though convex, for articulation with the ulna, while still more advanced toward the distal end we find the bicipital tuberosity, and, beyond, the minute nutrient foramen, all of the bones beyond the humerus being non-pneumatic. The distal extremity of the bone in question is terminated by a fanlike expansion that caps the ulna and articulates by its anterior convex margin with the radiale of the wrist. It is marked above by the longitudinal groove for the tendon of the extensor metacarpi radialis longus. The shaft of the ulna is nearly three times as large as that of the radius. Its outer half is straight, its inner curved toward the humerus, thereby increasing at the proximal moiety the interosseous space by the assistance of the opposite curve made by the radius. The stronger end is the one involved in the formation of the elbow-joint; here is to be observed the depression for the head of the radius, or the lesser sigmoid cavity, while the articular surface beyond that occupies the entire end of the bone, directed downward, inward and backward, presents for examination the greater sigmoid cavity, the olecranon and coronoid process, and the cavity for articulation with the oblique facet of the humerus. The greater sigmoid cavity is subcircular and of some depth; its lower and produced lip represents the coronoid process, as does its upper, better-marked and more tuberous prolongation represent the olecranon of andranatomia. Extending radiad is another concave, quadrate, articular facet for the oblique tubercle of the humerus, as the first-mentioned concavity articulates with the ulnar tubercle or trochlea. A little beyond this articular surface are various small tuberosities and depressions for the origin and insertion of muscles. Approaching the wrist the shaft is seen to be generally smooth, and diminishes in calibre at junction of middle and proximal thirds in the locality of the nutrient foramen, while along its entire length at certain intervals are the slight elevations for the apices of the quills of the secondaries. The distal extremity of the ulna enters into the formation of the wrist joint; it is not nearly so large as the proximal end. The articulating sur-

face has a deep mesial cleft in the vertical direction, limited externally by an elliptical curve, internally by a double tuberous knob for articulation with the irregularly formed ulnare of the carpus, while above is a roughened surface that is covered by the expanded end of the radius. The os prominens is not large in *Speotyto.*

The carpus in the adult is composed of the ulnare and radiale. The radiale articulates with radius, os magnum and ulna. The radial articulation is a rather deep and elliptical concave facet, its lower border gliding over the ulna, while the distal end of the radius plays in the concavity. The opposite face of this six-sided little bone is also smooth, and is a nearly flattened surface that articulates with os magnum. The upper and lower surfaces, as well as the ends, are simply roughened and fashioned to give the proper form to that part of the joint into which it enters, and for the attachment of ligaments. Os magnum has become confluent with the mid-metacarpal, forming its trochlear surface for articulation with radiale, ulnare and ulna. The ulnare is an extremely irregularly shaped bone; it appears to be rather the larger of the two free carpals, and is the lower in regard to position. It articulates with ulna and os magnum simply. Its outer ulnar facet is elliptical and shallow, monopolizing the entire face of the bone; its inner facet is very irregular, being formed so as to accommodate itself to the ulnar tubercles, with which it articulates. Projecting toward the metacarpus, this little bone has two prongs or limbs, the inner aspect of the extremities of each possessing a subcircular facet that articulates, the outer and shorter limb with the internal trochlear margin of os magnum, on the same side; the inner and longer limb straddles the metacarpal and glides over the surface, during movements of the joint, at a point about where magnum becomes confluent with mid-metacarpal. The ulnare has also attached to it ligaments that enclose the wrist-joint beneath—capsular ligaments of the carpus.

The metacarpus is formed in the usual manner, by the amalgamation of the pollex, medius, index and metacarpals, the first, second and third respectively. It is 3.3 centimetres long, articulating with radiale, ulna and ulnare at its proximal extremity by means of os magnum, that has become anchylosed with mid-metacarpal and the phalanges at its distal end. The first or pollex metacarpal is short, and fused with the second just anterior to the boundary of the trochlear surface of os magnum; it makes an

angle with the shaft of the second metacarpal, its extremity being directed upward. At its base, close to the shaft of mid-metacarpal, it bears a uniform facette for articulation with the thumb, a free, three-sided, pointed little bone, about nine millimetres in length. The second metacarpal is straight; its enlarged proximal extremity is formed chiefly by the confluent os magnum; its shaft is inclined to be subtrihedral, with its broadest face looking forward; its distal extremity is terminated by a knot-shaped enlargement, that is still further enhanced by the confluence with the third metacarpal. It bears a digit composed of two phalanges, the proximal one bearing on its posterior border, for nearly its entire length, a quadrangular expansion that has a raised margin, leaving a single concavity radiad; a similar concavity occurs on the ulnar side, but is there divided by a ridge sloping downward into two shallow depressions. This little bone somewhat reminds one of a cleaver, with the end of its handle attached to the metacarpus. It supports at its distal extremity the second phalanx of this digit, a bone having very much the same appearance and shape as the index digit, only being longer and more pointed. The proximal ends of all the phalangeal segments are more or less expanded, in order to support the ample facets of articulation that occur among them and the metacarpus. The third metacarpal is expanded transversely above, slender below, where it falls a little beyond the medius after its confluence with it. It also has a small pointed phalanx, freely attached to its distal extremity, and lying in that recess formed by the shaft and posterior expansion of the first phalanx of the second digit. At a very early date, comparatively, in the life of this Owl, ossification is normally extended to many of the tendons of important muscles of the antibrachium and pinion.

Of the Pelvic Limb.—The lower extremity is composed of twenty distinct segments, including the patella, or just double the number found in the pectoral limb. This increase will not surprise us when we recollect the greater number of small bones devoted to the foot above those found in the hand. Its most striking feature, next to those osteological characteristics common to the family, is its extreme length, due principally to the tibia and tarso-metatarsus. All the bones of the lower limb in this species are non-pneumatic. The femur is comparatively of good size and strong; articulated in the usual manner, it measures four centimetres in length and seven millimetres across the condyles at their widest part. At the proxi-

mal extremity, externally, above the shaft, there is a flat and roughened surface, bounded above by the curved trochanterian ridge. This surface forms the major part of the great trochanter. There is no trochanter minor present. The trochanterian ridge is the highest part of the bone, when it is held vertically; it lies in the antero-posterior plane, with the femur in its natural position, the bird standing erect; from it, sloping directly inward and occupying the remainder of the summit between it and the head, is a smooth articular facet, broadest externally, merging into the globular head internally.

With the head it constitutes the articular surface for the pelvis—it being opposed to the antitrochanterian facet of the ilium, while the caput femoris plays in the cotyloid ring. The excavation for the ligamentum teres on the latter is conical and deep, consuming a good part of the bone; it is situated on its upper and inner aspect. In looking into the relation existing among head, neck and shaft of the femur of this bird, we must observe that if the straight line lying in the middle of the surface of the internal aspect of the shaft were produced upward, it would pass through the centre of the facet at the summit—if anything, nearer the trochanterian ridge than it does to the head. This facet also is notably narrower just before arriving at the head than at any other point. Again, the plane passing through the external and circular boundary of the head makes an angle of a good forty-five degrees with this line, so that with these facts in view we can hardly assert in the case of the species before us, as do some authors on comparative anatomy in describing this bone *in general,* that the head of the feumur is either nearly at right angles with or is sessile with the shaft. It would appear, though, that it has quite as much of a neck to boast of as the anatomical neck of humerus or the neck of the scapula described for man's skeleton in works on human anatomy. The shaft throughout its length, until it begins to approach the distal condyles, where it is subcompressed and expanded antero-posteriorly, is nearly cylindrical, bends slightly backward at its lower end, and offers for examination merely the intermuscular ridges, with the linea aspera feebly marked, and the nutrient foramen, all of which maintain their usual positions on the bone. At the distal extremity the rotular canal, the intercondyloid notch and the popliteal fossa are all strongly produced, giving due prominence to the condyles, internal and external, between which they form the dividing tract.

The external and lower condyle is divided in two by a vertical excavation, deepest above. Of the two facets thus formed, the inner articulates with the tibia, the outer with the head of the fibula. The external surface of this condyle is flat and continuous with the shaft. The inner condyle, broad posteriorly, has a slight depression in the surface that bounds it on the tibial side, and as a rule the usual sites for ligamentous attachments about this extremity are at best but feebly represented. The patella, encased in the tendon of the quadriceps femoris, is situated about three millimetres above the rotular crest of the tibia, anteriorly, having the form of an oblate hemispheroid with its base directed upward, the long diameter of which measures 3.5 millimetres. The tibia is the longest bone in this bird's skeleton, and at the same time, taking this length into consideration, the least curved or bent along the shaft; it has, however, a slight and appreciable gradual curvative forward that is most apparent about the junction of middle or upper thirds. Its average length, measured on the inside, is 6.7 centimetres; its extremities being expanded for articulation, above with the femur, below with the tarso-metatarsus. These expansions are of about equal dimensions, though differing vastly in form; in this respect being unlike some of the diurnal *Raptores*, in which the distal condyles constitute the smaller end of the bone.

Among the most important points presented for examination about the head is the articular surface that crowns it above for the condyles of the femur. This is subquadrate in form, uneven, highest at the anterior and inner angle, sloping gradually to the opposite one, bounded almost entirely around by a raised margin, that is most feebly developed posteriorly and at a point anterior to the head of the fibula, where it is absent. In front, this border may be nominated the rotular or epicnemial ridge, though it is no more prominent there than at any other point; but in many birds it is so produced as to form a process of some size, to which these terms are applied. Externally and posteriorly the margin is roughened for the attachment of ligaments that bind the head of the diminutive fibula to this bone. In the middle of this articular surface is to be seen a tuberosity, on either side of which are the depressions for the femoral condyles. Produced downward, anteriorly, from the rotular ridge are the cnemial ridges; these have their crests bent slightly forward, and they merge into the shaft below, abreast the superior point of the fibular ridge. Of the two, the outer or

ectocnemial is the shorter—that is, it does not extend so far down the shaft as the inner or procnemial. They have between them an ovate concavity, with the larger end above, the lower end subsiding upon the shaft with the ridges themselves. The vertical elevation on the external aspect of the shaft for articulation with the fibula runs down the side but a short distance; a little below its abrupt termination may be observed, in a line with it, the nutrient foramen, entering very obliquely from above downward. After leaving the fibular ridge as far as the point where the bone begins to expand transversely at the distal extremity, the shaft is remarkably smooth and nearly cylindrical. This transverse and distal expansion is checked, both anteriorly and posteriorly, by abruptly meeting the distal condyles, the point of meeting perhaps being rather the higher behind. The condyles, differing but little in size, are singularly uniform as to shape, with their curved surfaces downward, being flat on their outer aspects, with a raised rim bounding them in each case. They stand out prominent and apart. Anteriorly their convex surfaces are the widest, behind they slightly approach each other, and the articular convex surface is narrowest on the outer condyle. The intercondyloid notch is deep, and appears equally well marked throughout its extent. Immediately above it, anteriorly, there is a deep triangular depression; another and more shallow one is found behind in the corresponding locality. Up the shaft a short distance on the inner side, anteriorly, is a little tubercle, to which is attached the ligament that binds down some of the strong tendons of the extensors. This ligament crosses the anterior triangular depression mentioned above obliquely, to be inserted near the external condyle superiorly. This is the arrangement also in *Bubo virginianus*, but in some of the Hawks this ligamentous bridge has become thoroughly ossified, forming a strong bony band across the concavity in question. It is interesting to remark here, however general the rule may be as applying to the diurnal and nocturnal *Raptores*, that whereas this band is ligamentous in the tibia in some of the Owls, a bony one fulfilling the same function is found in them just below the head of the tarso-metatarsus; these conditions are just reversed among some of the Hawks. Usually, in old birds of this species, the fibula is firmly united to the entire length of the fibular ridge of the tibia, a union almost amounting to anchylosis. Arching outward, its head, surmounted by an antero-posteriorly elongated

facet, rises a little above that bone at the point where it is attached to it by ligament. This is the larger part of the shaft in regard to size. Below the ridge this bone becomes simply a delicate little spine, that merges into the shaft of the tibia at about the junction of middle and distal thirds, though it may be traced after this as far as the middle of the outer condyle, where it terminates by a minute tubercle. The head is notched externally, near the centre, and has lodged at that point a small sesamoid that is in the lateral ligament of the knee-joint. Posteriorly on the shaft, about midway down the superior tibio-fibular articulation, we observe a small tubercle for the insertion of the tendon of the biceps. The long segment that exists between the tibia and the phalanges of the pelvic limb is the bone tarso-metatarsus, or the confluent metatarsals of the second, third and fourth toes with certain tarsal bones at its proximal extremity. It measures down the anterior aspect, mesially, 4.6 centimetres, and has its extremities enlarged for articular purposes, in common with other long bones of the skeleton. At its proximal end the bone presents superiorly two concave articular surfaces for the condyles of the tibia. They appear nearly on a level with each other, the bone being held vertically. The inner and larger of the two is elliptical in outline, antero-posteriorly; the outer and smaller is fashioned off behind by a tuberous process, directed upward and outward. Between these two surfaces arises a prominent tuberosity that in the articulated limb enters the intercondyloid notch of the tibia quite accurately, and is intended for ligamentous attachment. Anteriorly and internally a groove exists that runs down the shaft, to disappear a little above its middle. This canal is deepest immediately below the articular expansion, and is here bridged over by a little arch of bone, a millimetre in width, that serves to bind down and hold in its proper place the tendon of the long extensor of the toes. Posteriorly there is a much deeper and longer tendinal canal that extends the entire length of the shaft, being shallowest at the middle and most capacious at the proximal extremity; this is bounded above and internally for a short distance below the head of the bone by the hypotarsus, a thin lamina of bone that has a foramen near its base; this process is surmounted by an elliptical and compressed tuberosity, placed vertically. Above, the opposite wall of this groove is also thin, and extends in common with the calcaneal process, directed backward. There are two other foramina

seen at this end of the tarso-metatarsus; one just at the external termination of the bony bridge mentioned above, and the other outside and a little above it. Their posterior openings are immediately behind the anterior ones, or, in other words, they do not pierce the shaft in any way obliquely. The shaft of this bone is notably square on section for the major part of its extent, being encroached upon, however, both before and behind, by the aforesaid tendinal grooves. The tendons, especially those that occupy the posterior canal, are very prone to ossification, forming quite sizable bones in the adult, the largest of these being equal to the fibula in bulk, exclusive of course of the head of that bone, and not being as long. Returning to the tarso-metatarsus, we find at its distal extremity, for examination, the trochleæ that articulate with the rear segment of all the toes except hallux. Viewing this end with the bases of these trochleæ toward one, we find the general outline made by them to be crescentic, with the horns having a tendency to approach each other behind. The outer trochlea is the highest and longest from before backward; the other two are about on the same level, the inner one having a posterior and internal process, while the middle one is possessed of a median cleft traversing its face antero-posteriorly. They are sharply divided from each other by narrow slits that extend up as far as the articulating part, and are continued on the anterior aspect of the shaft for a short way as delicate groovelets. A foramen is situated in the outer of these that gives passage to the anterior tibial artery, and is comparatively larger than is usually seen in the Owls. Behind, the tendinal groove expands, and is bounded distally by the concave border formed by the trochleæ. Upon its internal margin, just above the extremity of the bone, it shows an elongated but feebly marked depression of about three millimetres in length. This facet articulates with the os metatarsale accessorium, which is joined to the bone by ligament. This little bone in this bird has an average length of four millimetres. It is twisted upon itself, and bears upon one border a convex, smooth surface for the tarso-metatarsus, while distally it has an articulating surface, resembling more the mid-trochlea than any other, for the proximal segment of the hallux. Above it is sharply grooved for the tendon that goes to that toe. The toes are four in number, and their joints follow the rule that governs the greater part of the class *Aves*—that is, first, second, third and fourth toes have two, three, four and five pha-

langes allotted to them, respectively. The first phalanx of the hind toe is more compressed from side to side than in the other toes, possessing more of the characteristics of the second joint. Its posterior facet, that articulates with the accessory metatarsal, fits accurately into the cleft surface seen on that little bone. Anteriorly the facet has a median groove, forming two vertical convexities for the double concave facet on the claw, with its dividing ridge. The claws are all a good deal alike, varying in size, the rear one being the most compressed laterally. They are pointed, arched and nearly conical, the horny thecæ that cover them during life only being grooved on the under side. Their proximal ends have an articulating facet for the next phalanx behind them; this is so arranged that they can be more smartly flexed than any of the other joints of the foot, due to the convex articulating surface extending well beneath on the phalanx they meet. On the under side of their proximal extremities is a tuberosity for the attachment of the flexor tendons; it has on either side, below, an oval foramen to allow vessels and a nervelet to pass to the extremities of these ungual phalanges. The first joint of the second toe, and the first and second of the third, are thickest and short, articulating internally with the tarso-metatarsus, and having their facets so arranged as to allow of motion only in the one plane. These bones may almost be said to interlock with each other, with their superior projecting processes behind fitting closely into the deep groove intended to receive them on the anterior faces of the joints to their immediate rear. The remaining phalanges of these two toes resemble the proximal segment of hallux. The fourth or outside toe possesses five phalanges, but the three innermost segments are very short, and are really nothing more than one of the middle type of phalangeal bones, such as the third on the mid-toe, divided into three nearly equal parts, the proximal and distal pieces retaining all the characteristics of that bone, while the middle segment is simply a mid-section of the shaft. This arrangement, however, together with the manner in which the proximal phalanx articulates with the long and elevated trochlea on the tarso-metatarsus, gives this toe a versatility and a power to be thrown outward and, to a limited extent, to the rear that is not enjoyed by any of the other toes, constituting as it does one of the interesting anatomical features that we find in the family *Strigidæ*.

So much then for the osteology of *Speotyto*. The account of it

I have just given above sinks far into the realm of details, but occasionally such descriptions are very useful, and it is hoped that it will be found to be the case in the present instance.

There are at my hand two skeletons of the nestlings of the Great Horned Owl (*Bubo virginianus*) that I secured from alcoholic specimens presented me by Dr. Strode, of Bernadotte, Illinois. (See Pl. X, Figs. 1–4.) They were taken by him at the time the birds were on the point of quitting the nest to shift for themselves. Some points of great interest are to be observed in either of the skeletons of these Owlets, as in them all the separate osseous elements of this part of their economy are still individualized. For example, in the skull the small yet distinct orbito-sphenoids are seen to be ossified, and the basitemporal is beautifully defined. The basipterygoid processes are as well developed as we find them to be in an old bird of the same species; while the interorbital septum is at this time only performed in membrane. On the vault of the cranium the sutures among the parietals, frontals, and squamosals are in close contact for their entire marginal lengths; this is not quite the case, however, with the bones of the base of the skull. The otic elements are likewise quite distinct, and the vomer has not as yet ossified.

Passing to the remainder of the trunk skeleton, we note the usual state of building up, by their elements, of the various vertebræ all throughout the spinal column; and find, moreover, that *three* vertebræ enter into the formation of the pelvic sacrum.

No bone at all is as yet to be detected in the sternum, although the clavicles are now quite perfectly ossified, completely united below, and the arch possesses no little strength. The remaining bones of the shoulder-girdle, as well as the ribs, are well on toward ossification, though in form they are still quite primitive.

In the wing all the elements are thoroughly independent of each other, and the structure as a whole is always brimful of interest to me. We find that the os prominens has not yet ossified, and only a tiny nodule of bone can be detected either in the radiale or the ulnare. The expanded part of the proximal phalanx of index digit is entire, and all the finger-joints are pretty well ossified.

With respect to the pelvic limb we observe that the proximal extremity of the femur presents but a club-like end, and no hint is as yet betrayed of the formation in bone of its head, neck or the trochanter. At least three bony ossicles are to be discovered in the

tarsus, as well as an ascending process of the astragulus. The latter is quite conspicuously marked. Fibula is noted for its length, but all signs of a fibular articular ridge on the side of the shaft of tibio-tarsus are still wanting. The two bones simply lie alongside of each other, faint indications of any coössification being seen only at their distal ends. Fusion is fairly well advanced among the metatarsal elements, omitting, as I do of course, the small accessory one for hallux, which, as we know, remains permanently free throughout life. Finally, the bones of the feet are seen to be in a stage of ossificatory advance well in keeping with the other elements of the limb of which I have just been speaking.

Other Owls of the United States avifauna present us with very interesting characters in their osseous systems. Upon examining a skeleton of *Asio wilsonianus* (Pl. XV, Figs. 22 and 23; also Pl. XVII, Fig. 30), we are confronted in it with a strigine skull quite different in its pattern from anything we find in *Bubo*. In conformation it is symmetrical, so far as its auricular region is concerned. Both nasal and interorbital septa are absolutely entire, and I have yet to see a skull of this species that has a perforation in either of these partitions. One of the most characteristic features is the manner in which the postero-superior margin of either orbit is broadly flattened out, while each supraorbital process is decurved, pointed and prominent, and projects over the middle point of the orbit from above. The tympanic bullæ are large and open; the postfrontal processes rather small and jutting well out from their bases. Behind these, on either side, another long spiculiform process is sent down in front of the quadrate. It is directed forward and downward. The pars plana is upon the bubonine type, and the maxillo-palatines are of fairly large size. Coming to the vomer we find it of some considerable size, being pointed in front and fused with the palatines posteriorly. Both the pterygoids and the quadrato-jugal bars are straight and unusually slender for an Owl. The pterygoidal heads of the palatine bones are conspicuously separated, a condition that throws the anterior ends of the pterygoids themselves widely apart in this skull. They are never in contact, I believe, in any Owl. *Asio* is noted for another feature in its skull—this is the peculiar flatness of the posterior aspect of the cranium, as well as its unusual width and height for a skull of its comparative size.

Finally, we are to note that the interorbital septum is relatively much thicker in the transverse direction than we find it in other

bubonine genera, as for instance *Bubo* or *Speotyto*. The post-palatine blades are broadish, flat and thin, quite unlike other Owls.

This Long-eared Owl has a mandible of the same general pattern as seen among the *Strigidæ* generally. The bone is rather light; the inturned processes of the articular ends are longer than usually seen in other species and genera; the superior margin of either ramus, near its middle, is gently curved outward; the ramal vacuity is ragged and slit-like in the longitudinal direction. Fig. 6 and Fig. 30, Pl. XVII, give a good idea of the skeleton of the trunk in *Asio*, and I would only call attention to one peculiarity here, and we are to note that the grooves on the front of the sternum for articulation with the coracoids decussate, as they do in certain diurnal Raptores. This is not the case in *Strix pratincola*, but is seen in *Bubo maximus* and other bubonine Owls.

The clavicles are firmly united below, and a coracoid is pierced through its shaft in the same manner as we found it in *Speotyto*.

The wing bones are comparatively long, and the humerus (Pl. XV, Fig. 22) alone pneumatic, and it highly so, the foramen being almost circular and flush with the general surface of the bone. I have not seen the os prominens in this species, and am inclined to believe that it is either very rudimentary or perhaps entirely absent. The expanded portion of the first phalanx of index digit is very thin, and divided near its middle by an oblique osseous ridge. We noted that it was solid and nearly of uniform thickness in *Bubo*, twice perforated in *Strix*.

Respecting the pelvic limb, the long bones of thigh, leg and metatarsus offer no special departures from those structures in ordinary Owls at large; but in the foot, attention is called to the relative lengths of the first and second phalanx of the third toe. These are subequal, to be sure, but not in the same degree as we found in *Bubo*, for here in *Asio* the second phalanx is relatively longer than the same joint in the Great Horned Owl.

Several species of the genus *Syrnium* present us with interesting characters in their skeletons.

Dr. Robert Collett has given us quite a number of good figures of the skulls of various species of *Syrnium* in his well-known memoir entitled "Craniets og Oreaabningernes Bygning hos de nordeuropæiske Arter af Familien Strigidæ," a translation of which, including additional matter and all the original plates and figures, has been published by the present writer, as stated in the Introduction,

in the *Journal of Morphology* (Boston, U. S. A., Vol. XVII, No. 1, 1900, pp. 119–176, Figs. 1–7, Pls. XV–XX). Taken in connection with all we have already recorded upon the skull of these birds in several genera, it will not be necessary to dwell upon this part of the skeleton in *Syrnium*, as the figures to which allusion has just been made will be fully sufficient to show the special characters and form of it. (See Pl. XIII, Figs. 13 and 15.) One point of note is to be observed, however, and that is in some species of *Syrnium* the skull is symmetrical, while in some others asymmetrical distortion to a moderate degree is observable. Of the first condition *S. nebulosum* is an example, and of the latter *S. cinereum* furnishes us an instance. It is symmetrical in *Pulsatrix torquatus*. (Pl. XVIII, Fig. 13.) In this genus *Syrnium* the outer pair of notches of the sternum are conspicuously deep; the manubrium is well pronounced; the coracoidal grooves slightly cross each other; the clavicles are firmly united below, and the os prominens is of some considerable size. An interesting little point is seen in the femur, where the pit in the head of the bone for the ligamentum teres is very much deeper than is usually the case among birds.

Another Owl that exhibits a peculiar asymmetry of the cranium is *Scotiapex c. lapponica*; here the postfrontal wing is thrown farther outward on the right side, something after the order found in a species of the genus *Syrnium*, to which we referred in the last paragraph.[1]

Probably the best examples of cranial asymmetry among the *Strigidæ* are to be seen among the representatives of the genus *Nyctala*, as, for instance, in *N. tengmalmi*. Here it does not involve so much the position of the postfrontal processes as it does distort the squamosal region of the skull upon either side. A skull of this bird has been nicely drawn for us by Collett, as stated above, and republished by me in the translation of his paper.

How such a condition as this asymmetry came to be evolved will probably remain one of those enigmas in zoölogy not to be solved through the researches of man. It is difficult for me to see what

[1] This statement in reference to *Scotiapex* must, for the present, be taken with caution, as the observation was made by me upon a skeleton so labeled in the United States Army Medical Museum at Washington, and I know to my cost that the diagnoses of specimens in many cases in that collection are incorrect to a degree probably unparalleled in any institution in existence. In my own collection I have but the trunk skeleton of *Scotiapex*.

especial advantage it can bestow upon the bird, or how it would better fit it for the struggle for its existence. Apparently the largest and most powerful Owls in the world have perfectly symmetrical crania; while, as I have already noted above, the largest species known to me wherein evident asymmetry is present in that part of the skeleton is *Syrnium cinereum*. On the other hand, our very smallest owls, the pygmies of the group, as *Glaucidium and Micropallas* (see Pl. XIV, Figs. 17 and 18), possess wonderfully symmetrical little skulls, barely exceeding in size the skull of a large Thrush.

Other ornithologists have invited our attention to this cranial asymmetry as exemplified by the genus *Nyctala*. As long ago as 1870 Dr. T. H. Streets, of the United States Navy, referred to it in the *Proceedings of the Academy of Natural Sciences of Philadelphia* (p. 28); and in the *History of North American Birds*, Mr. Ridgway has figured the skull of Richardson's Owl (*N. richardsoni*), showing the same character.

Nyctea nyctea (see Pl. XII, Figs. 8 and 11; Pl. XVI, Figs. 26, 28 and 29) has a skeleton that in all essential particulars closely resembles that part of the anatomy of *Bubo virginianus*. The bird clearly belongs to the bubonine section of the group.

Screech Owls, or what we call the Screech Owls in the United States, are of many species and subspecies in the fauna. They have had the genus *Megascops* created to contain them, and I have examined complete skeletons of a number of the varieties. After the bubonine order in point of skeletal structure, they yet exhibit some interesting little peculiarities of their own. (See Pl. XIII, Figs. 12 and 16; Pl. XIV, Fig. 19.)

Megascops asio trichopsis (or any of its genus) has a skull more like that part of the skeleton in *Speotyto* than any other of our Owls, with the exception of *Surnia*. It differs, however, in possessing a well-developed vomer, whereas it lacks the process on the quadratojugal bar seen in the Burrowing Owl. *Megascops* has an extensive internasal septum which is quite thick and extends well backward. The interorbital septum is thin, and may show a small vacuity near its centre. Either superior border is but very slightly rounded off, it being quite sharp in *Speotyto*. Another point wherein these two Owls agree and differ from others is the formation of the foramen in the squamosal region of the cranium, through which the tendon of the temporal muscle passes. This character was described when

speaking above of the same condition as it occurs in *Speotyto*. In *Megascops* the supraorbital processes are very nearly entirely aborted, and in young Burrowing Owls they are not very strongly pronounced. Both forms have symmetrical skulls, and in both the mandibles are almost entirely alike.

With respect to the remainder of the skeleton, a *Megascops* has the four-notched sternum, in front of which the coracoidal grooves do not decussate, and the manubrium is small. The os furcula is a single U-arch and a weak one. At the distal end of the radius in the skeleton of the wing the os prominens is almost of rudimentary proportions. Finally, aside from specific variations in form, all the other components of the representatives of this genus agree with the bubonine type of structure.

Already I have noted the fact above that *Surnia ulula* approaches *Speotyto* closely in some of the characters of its skeleton. This is especially noticeable in the skull, where not only the general contour of that structure in the Hawk Owl strongly reminds one of the skull of *Speotyto*, but we find the resemblance to be real when we come to examine and compare some of the details. For instance, the external narial apertures are subcircular, or we might say broadly elliptical in *Surnia*, just as they are in the Burrowing Owl; and, moreover, we find find the supraorbital processes to be of the same form in each. *Surnia* further has the process on the upper side of the quadrato-jugal bar, although it is not as strongly pronounced as it is in *Speotyto*. Again, *Surnia* lacks a vomer, and the structures at the base of the cranium very closely resemble the corresponding ones in the Burrowing Owl.

In the sqaumosal region, however, the foramen for the passage of the tendon of the temporal muscle does not form as it does in *Speotyto*, there being but a broad notch in the place of it.

The mandibles are very much alike in the two birds; and the remainder of the skeleton in *Surnia* is fashioned upon the type in the bubonine Owls generally.

Lastly, we must say a word about the skeleton in those dwarfs of the Strigine race, the Pygmy and Elf Owls. Personally, I have never examined the skeleton of a *Glaucidium*, but on the other hand I possess three skeletons of *Micropallas whitneyi*, a smaller Owl than any of the pygmies[1] (see Pl. XIV, Figs. 17 and 18).

[1] I am indebted to Mr. Herbert Brown, of Tucson, Arizona, for this valuable

These diminutive birds, so far as we can judge from *Micropallas*, possess a skeleton that has in it many characters that remind us of the skeleton in *Speotyto*. The general form of the skull is much the same, although it will be seen that in *Micropallas* the fronto-supraorbital processes are almost entirely aborted. Both species apparently lack a vomer, while, too, both have the peculiar expansion on the upper side of the quadrato-jugal bone. This is very conspicuous in *Micropallas*, and appears to have something to do with making a more complete bony periphery for the orbit. The sclerotal plates of the eyeball rest against it below. Superiorly, round behind and at the sides, *Micropallas* has an unusually rotund cranium, and shows in the squamosal region a notch for the transmission of the tendon of the temporal muscle. No asymmetry is noticeable in the skull, and the arrangement of the bones of the roof of the mouth are very much as we found them in the Burrowing Owls. A good-sized ramal vacuity exists in either ramus of the mandible and the hyodean apparatus essentially agrees with *Speotyto*. Other points worthy of notice in the skeleton of *Micropallas* are: it has in the arm a pneumatic humerus, and a very small os prominens at the distal end of radius over the wrist. Its os furcula is feeble, but thoroughly united below; the manubrium of the sternum is well pronounced, and the sternum itself four-notched. When *in situ* the coracoids are well apart at their sternal extremities, and the shafts of those bones are each pierced by a foramen, in a manner similar to what we find in so many Hawks and Owls. Its vertebræ and ribs, between skull and pelvis, agree with the bubonine type of Owls generally, but it seems to possess a fewer number of caudal vertebræ, never as many as eight free ones, as we find in other representatives of this group of birds. Another structure we must observe is its pelvis; this differs considerably in pattern from what we see as a rule in most other Owls, for in some respects it reminds me not a little of the pelvis as I have found it in certain Passerine types. In it the pelvic basin is not noticeably contracted nor deep; and what is still more striking, there is no inclination for the post-pubic bones to curve toward each other posteriorly. They project

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material, and at the time I received it there was not a skeleton of a *Micropallas* in any of the collections of the larger institutions of the United States nor in Europe. Moreover, I understand, the bird, through the persistent destruction of collectors, stands much in danger of becoming extinct.

directly backward, as do also the ischia above them. Aside from the disproportion we see in the relative lengths of the bones of the leg of *Speotyto*, *Micropallas* has a skeleton of that extremity much as we find it in those birds. Its fibula is exceedingly slender and considerably shorter than the tibio-tarsus; the arrangement and structure of the podal joints of pes is bubonine.

ON THE AFFINITIES OF THE UNITED STATES STRIGES.

Regarding the Owls as a whole, the present writer considers them to be a group of nocturnal birds of markedly raptorial habits. Some of the species, however, are largely diurnal in their ways. They are not especially related to the *Accipitres*, but are, on the other hand, remotely allied with the *Caprimulgi*. What we now know of the structure of such forms as *Steatornis* and *Podargus* sufficiently indicate this much.

Taking the Owls in our own avifauna, they may readily be grouped into two well-marked families—the *Strygidæ*, to contain *Strix*, and the *Bubonidæ*, to contain all the other genera. *Strix pratincola* comes nearer the *Caprimulgi* than any other of our Strigine types. This is remotely suggested to us by the form of its sternum, the general aspect of the skull and a few minor points elsewhere in the skeleton. Of all the bubonine Owls we are inclined to think that *Asio wilsonianus* comes nearer *Strix* than any of the others. There is also doubtless an affinity among the genera *Surnia*, *Speotyto* and *Micropallas*. *Bubo* and *Nyctea* are strong types, with a great raptorial aspect in the cast of their skeletons, more especially in their beetle-browed skulls and their powerful raptorial feet.

Perhaps the asymmetry of the skull may also point to generic affinity, though it is a question; but if so, then *Syrnium*, *Surnium* and *Nyctala* may be considered more closely related among themselves than they are with any of the other genera.

Megascops approaches *Bubo*, and has a few characters, of light weight, in its skeleton that agree with the corresponding ones in *Speotyto*.

Explanation of Plates.

[The figures in these Plates are all reproductions of photographs made direct from the specimens by the author, represented by material either in his own private collection or in the collections of the U. S. National Museum at Washington, D. C., U. S. A.]

Plate X.

Fig. 1. Basal view of the skull of a nestling Great Horned Owl (*Bubo virginianus*). Mandible articulated, but a number of the bones of vault of cranium and face removed. Maxillaries and maxillo-palatines somewhat displaced. Natural size. Specimen in the author's collection, and taken for him by Dr. W. S. Strode, of Bernadotte, Ill. The nestling was just quitting the nest.

Fig. 2. Basal view of the skull of nestling *Bubo virginianus*. Belonged to the same clutch as the one in Fig. 1, and has the same history. Natural size and shows how these birds vary in the matter of proportions when hatched nearly at the same time. Figs. 1 and 2 show well the sutural lines at the base of the cranium.

Fig. 3. Outer aspect of the right pelvic limb of the nestling *Bubo virginianus*. Natural size, and from the same specimen to which the skull shown in Fig. 2 belonged. This specimen exhibits very well the ossific centres and development of the epiphyses about upper part of the ankle-joint.

Fig. 4. Palmar aspect of the right pectoral limb of the nestling *Bubo virginianus*. Natural size, and from the same specimen to which the skull shown in Fig. 2 belonged, as well as the pelvic limb in Fig. 3. The humerus and distal phalangeal digit are somewhat turned aside from their normal positions.

Plate XI.

Fig. 5. Right half, internal view of the skull of an adult specimen of the Great Horned Owl (*Bubo virginianus*). Natural size and showing comparative proportions of brain cavity, the amount of diplœic tissue and other structures. Mandible removed, but quadrate and pterygoid *in situ*. (Spec. No. 17139, Coll. U. S. Nat. Mus.)

Fig. 6. Left half, internal view of the skull of *Bubo virginianus*. Natural size and from the same specimen as shown in Fig. 5.

Fig. 7. Superior aspect of the skull of an adult specimen of the Great Horned Owl (*Bubo virginianus*). Natural size and the mandible removed. From an unnumbered specimen in the Collection of the U. S. National Museum.

Plate XII.

Fig. 8. Basal view of the skull of an adult specimen of the Snowy Owl (*Nyctea nyctea*). Natural size and with the mandible removed. (Spec. 18458 of the Coll. of the U. S. Nat. Mus.)

Fig. 9. Dorsal aspect of the pelvis and three anterior caudal vertebræ of an adult specimen of the Hawk Owl (*Scotiapex cinerea lapponica*). Natural size and from a specimen in the author's private collection; it having been presented to him by Mr. Ernest Seton-Thompson, who collected it near Toronto, Canada, in May, 1890.

Fig. 10. Left lateral view of the skull and mandible of an adult specimen of the Great Horned Owl (*Bubo virginianus*). Natural size and the same skull as shown in Pl. XI, Fig. 7.

FIG. 11. The ventral aspect of the sixth to the twelfth cervical vertebræ of an adult specimen of the Snowy Owl (*Nyctea nyctea*). Natural size and from the same specimen which furnished the skull shown in Fig. 8. (Coll. U. S. Nat. Mus., No. 18458.)

PLATE XIII.

FIG. 12. Basal aspect of the skull of an adult specimen of the Screech Owl (*Megascops asio*). Natural size, mandible removed, but with the circlets of sclerotals of the eyes left *in situ* in the orbits. When photographed the skull was slightly rotated to the left. (Spec. No. 18987 of the Coll. U. S. Nat. Mus.)

FIG. 13. Superior aspect of the skull of an adult specimen of *Pulsatrix torquato* from Nicaragua. Natural size and mandible removed, which latter is shown in Fig. 15. (Coll. U. S. Nat. Mus., No. 18350.)

FIG. 14. Superior aspect of the skull of an adult specimen of the American Hawk Owl (*Surnia ulula caparoch*). Natural size and mandible removed (in author's private collection).

FIG. 15. Superior aspect of the lower mandible of an adult specimen of *Pulsatrix torquata*. Natural size and from the same specimen which furnished the skull shown in Fig. 13.

FIG. 16. Left lateral view of the trunk skeleton, shoulder-girdle and the femora of a specimen of the Screech Owl (adult), *M. asio*. Natural size, and belonged to the same specimen which furnished the skull shown in Fig. 12. The os furcula is broken near its lower part.

PLATE XIV.

FIG. 17. Left lateral view of the entire skeleton of an adult specimen of the Elf Owl (*Micropallas whitneyi*). (Ligamentous preparation.) Very slightly reduced from a specimen in the author's collection, and presented to him by Mr. Herbert Brown, of Tucson, Arizona (May, 1890). The windpipe is broken and protrudes in front of the cervical vertebræ. The circlet of sclerotal plates are in the left orbit. This is the skeleton of one of the smallest of the existing species of Owls in the world.

FIG. 18. Superior aspect of the skull of an adult specimen of the Elf Owl (*Micropallas whitneyi*). Very slightly reduced and mandible not removed. Another specimen other than the one shown in Fig. 17, but with the same history.

FIG. 19. Left lateral aspect of the skull and mandible of an adult specimen of the Screech Owl (*Megascops asio*). Very slightly reduced and with the sclerotal plates of the left eye *in situ*. Same skull as shown in Plate XIII, Fig. 12.

FIG. 20. Anterior aspect of the sclerotal plates of the right eye of an adult specimen of the Great Horned Owl (*Bubo virginianus*). Very slightly reduced, and from the same skeleton to which the skull belonged shown in Plate XII, Fig. 10.

FIG. 21. Superior aspect of the skull of an adult specimen of the American Barn Owl (*Strix pratincola*). Very slightly reduced. Hyoid arches wired to the skull *in situ*, and this is seen through the left orbit. (Spec. No. 18196 of the Coll. U. S. Nat. Museum, and the same specimen as shown in Plate XV, Fig. 24. Mounted in the cases of the Osteological Department, and kindly loaned by Mr. F. A. Lucas.)

PLATE XV.

FIG. 22. Palmar aspect of the right humerus of an adult specimen of the American Long-eared Owl (*Asio wilsonianus*). Author's collection, and taken by him

at Fort Fetterman, Wyoming, U. S. A., in April, 1881. Natural size, and from the same skeleton to which the parts shown in Fig. 23 and Fig. 30 of Plate XVII belonged.

FIG. 23. Basal aspect of the skull of *Asio wilsonianus*. Natural size, mandible removed (see history in Fig. 22).

FIG. 24. Right lateral aspect of the skull of an adult specimen of the American Barn Owl (*Strix pratincola*). (History given under Plate XIV, Fig. 21, where the same skull is shown on superior view).

FIG. 25. Left lateral view of the trunk skeleton and left femur of the American Barn Owl (*Strix pratincola*). Natural size. Author's private collection, and taken near New Orleans, La. (1883).

PLATE XVI.

FIG. 26. Anconal aspect of the left carpo-metacarpus of the Snowy Owl (*Nyctea nyctea*). From same specimen which furnished the skull in Fig. 8 of Plate XII, and also the humerus and coracoid and scapula of the present plate (Figs. 28 and 29). Somewhat reduced.

FIG. 27. Ventral aspect of the sternum of the American Hawk Owl (*Scotiapex cinerea lapponica*). Somewhat reduced, and from the same skeleton which furnished the pelvis shown in Fig. 9 of Plate XII. A few of the costal ribs have remained attached.

FIG. 28. Palmar aspect of the left humerus of the Snowy Owl (*Nyctea nyctea*). Adult, somewhat reduced (see description of Fig. 26).

FIG. 29. Inner aspect of the left coracoid and scapula, normally articulated, of the Snowy Owl (*Nyctea nyctea*). Somewhat reduced (see descriptions of Figs. 26 and 28).

PLATE XVII.

FIG. 30. Left lateral aspect of the trunk skeleton of the American Long-eared Owl (*Asio wilsonianus*). Natural size, and from the same skeleton that furnished the skull and humerus shown in Figs. 22 and 23 of Plate XV, where the history of the specimen is recorded.

Stated Meeting, December 21, 1900.

Vice-President SELLERS in the Chair.

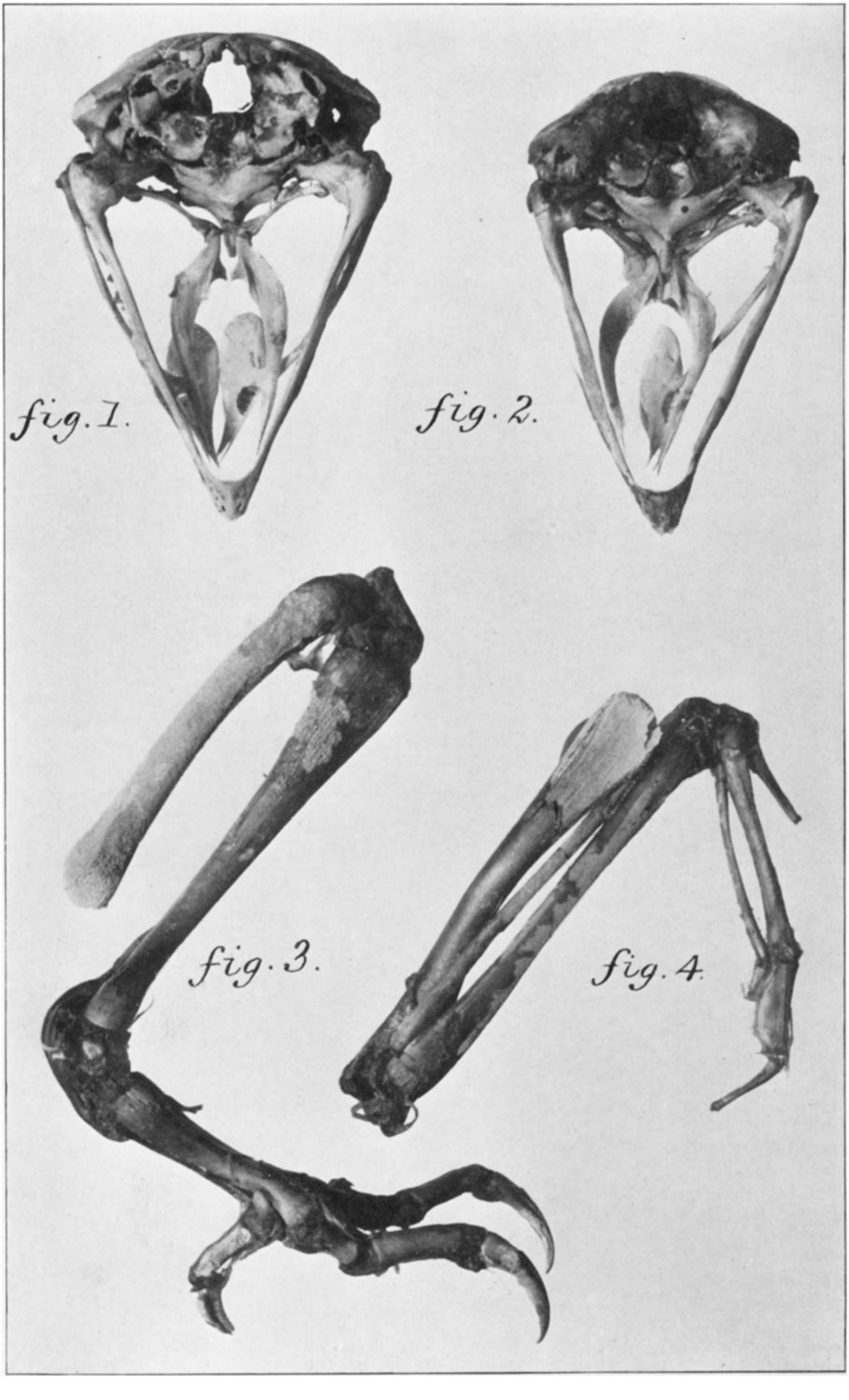
Present, 18 members.

Donations to the Library were announced and the thanks of the Society ordered therefor.

The report of the Finance Committee was presented.

Nominations for Officers and Councillors were made.

The meeting was adjourned by the presiding officer.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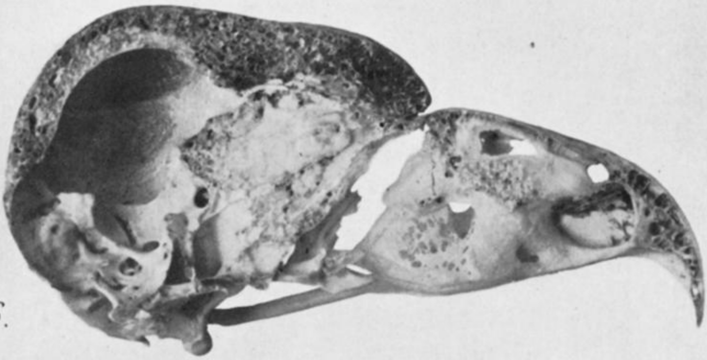

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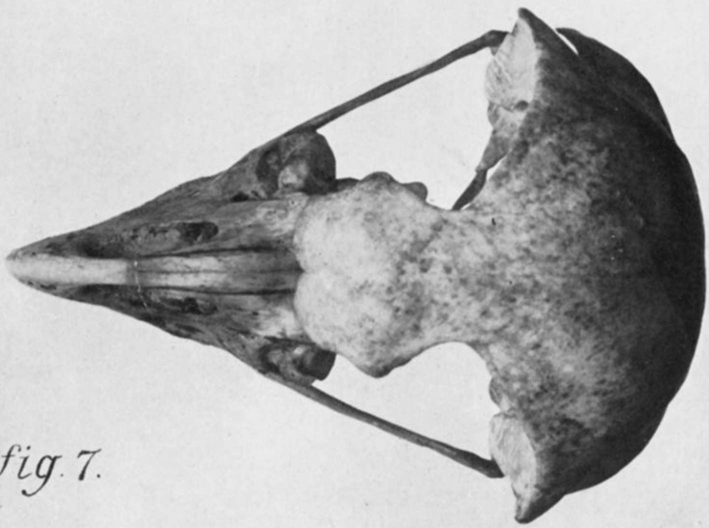

fig. 7.

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fig. 9.

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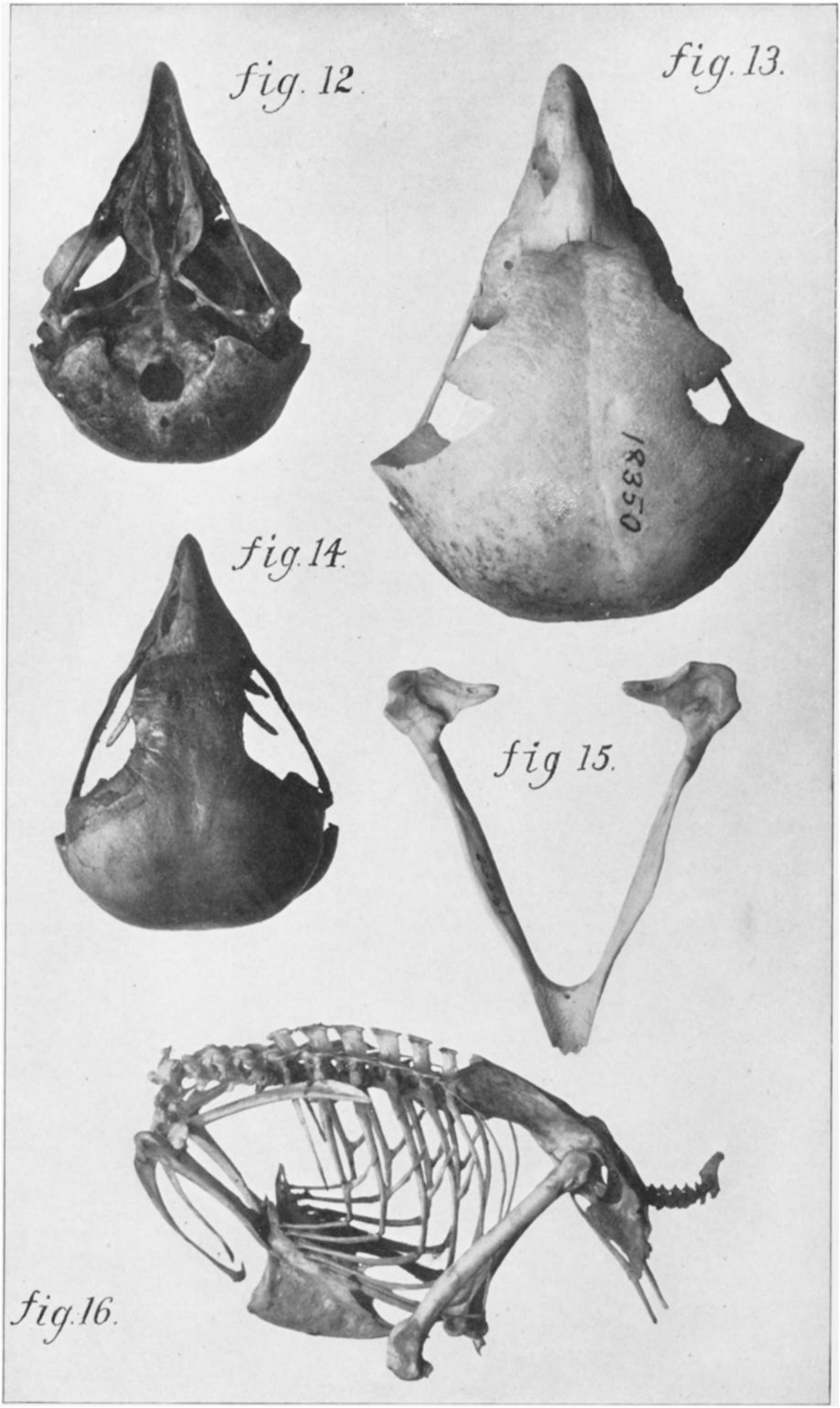
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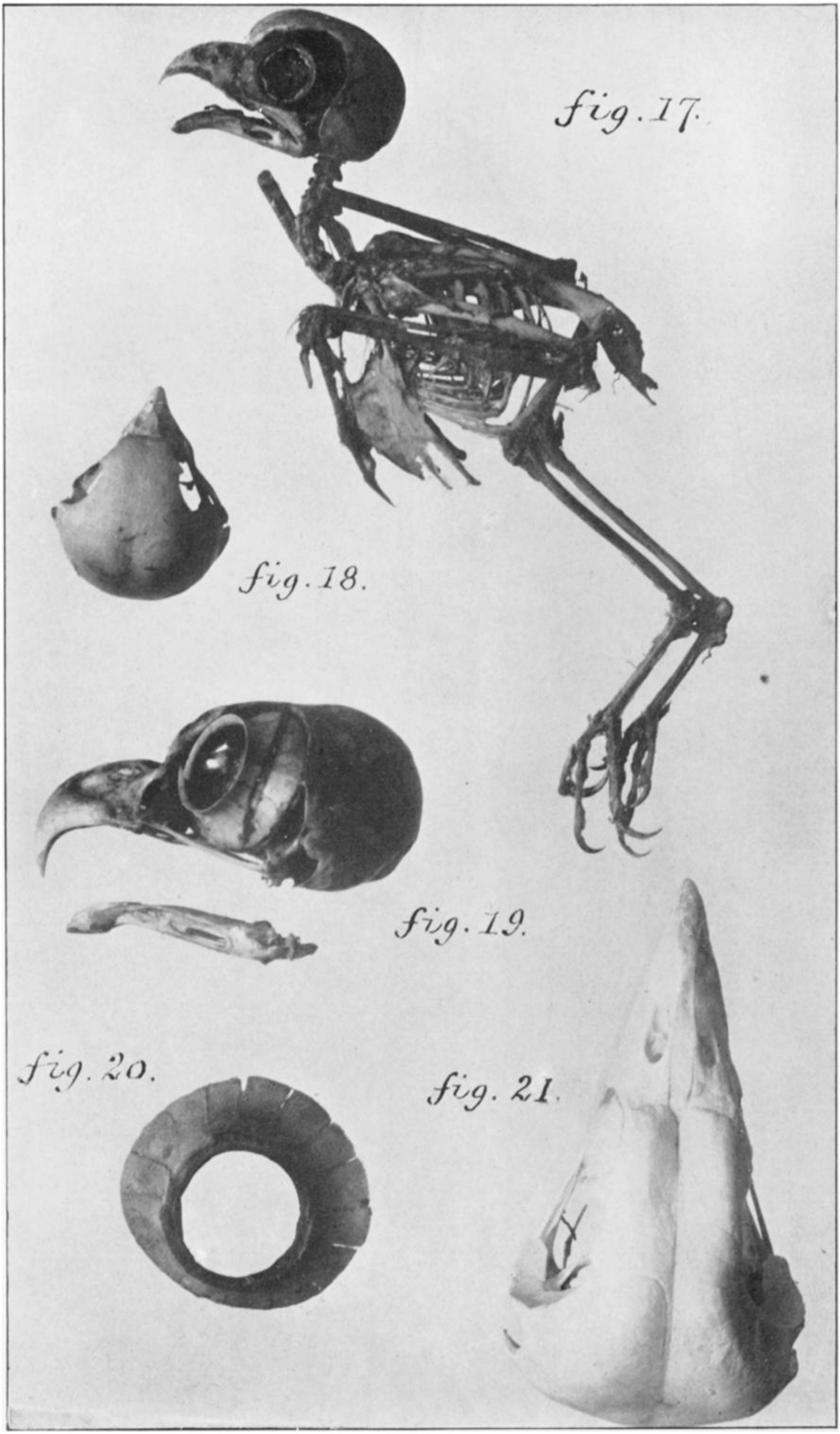
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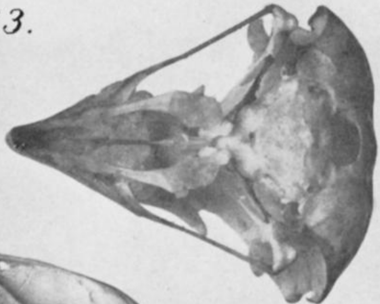
fig. 18.
fig. 19.
fig. 20.
fig. 21.

fig. 22.

fig. 23.



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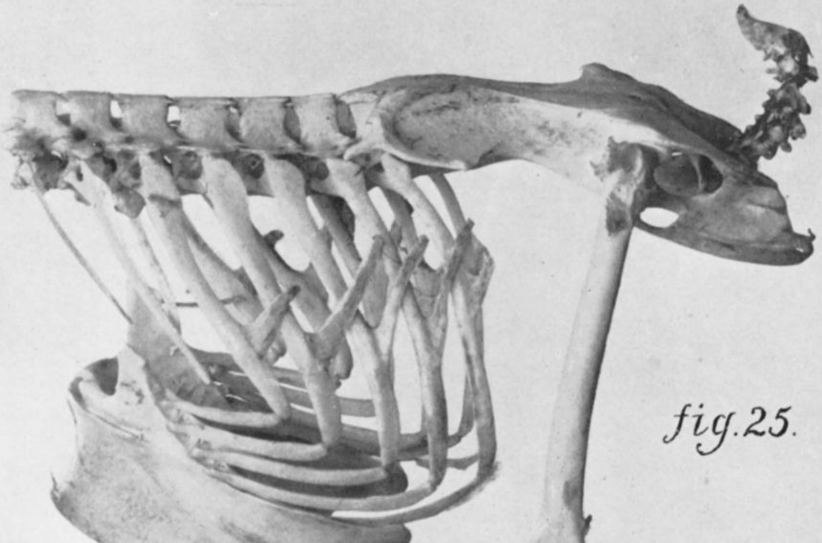

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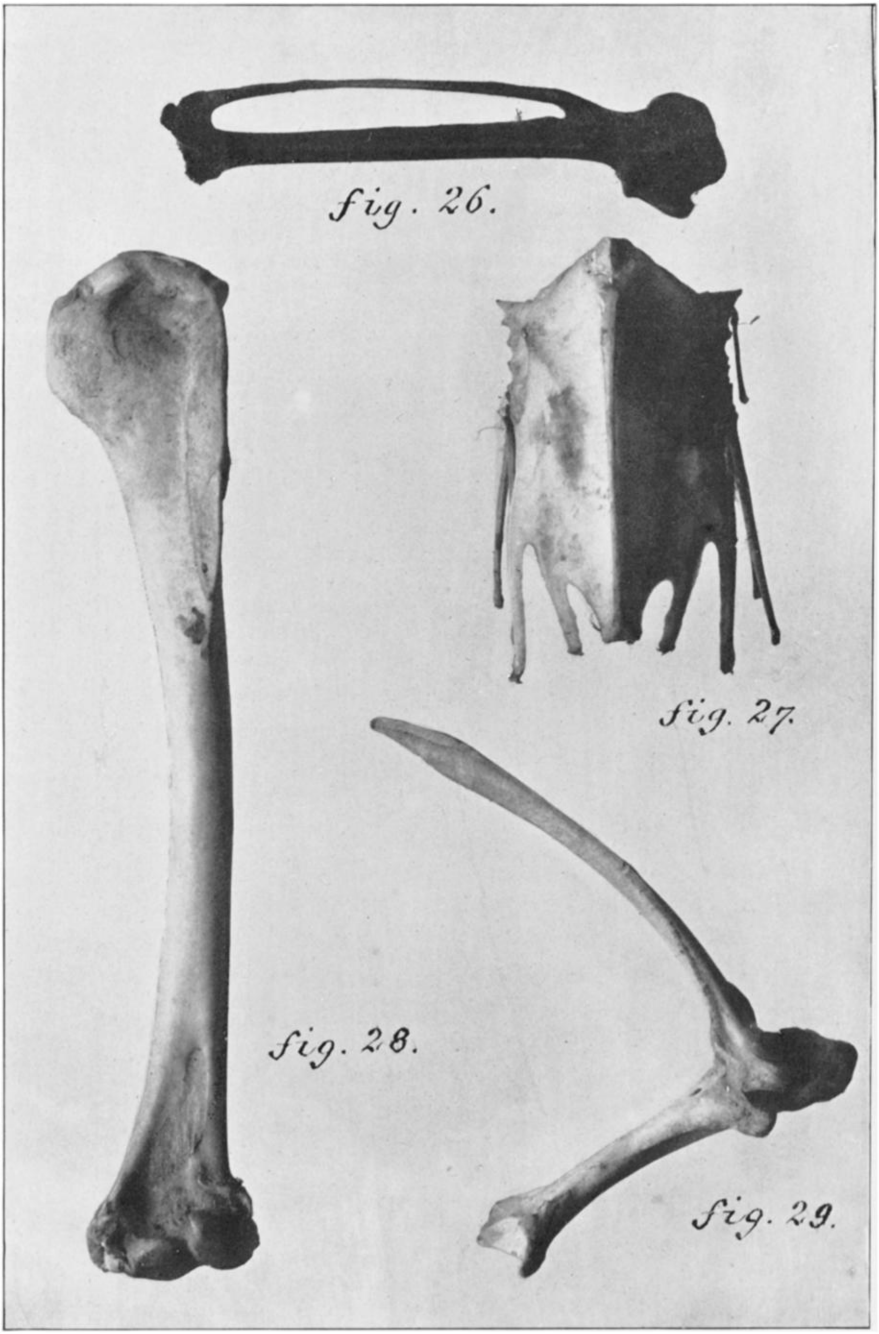

fig. 26.

fig. 27.

fig. 28.

fig. 29.

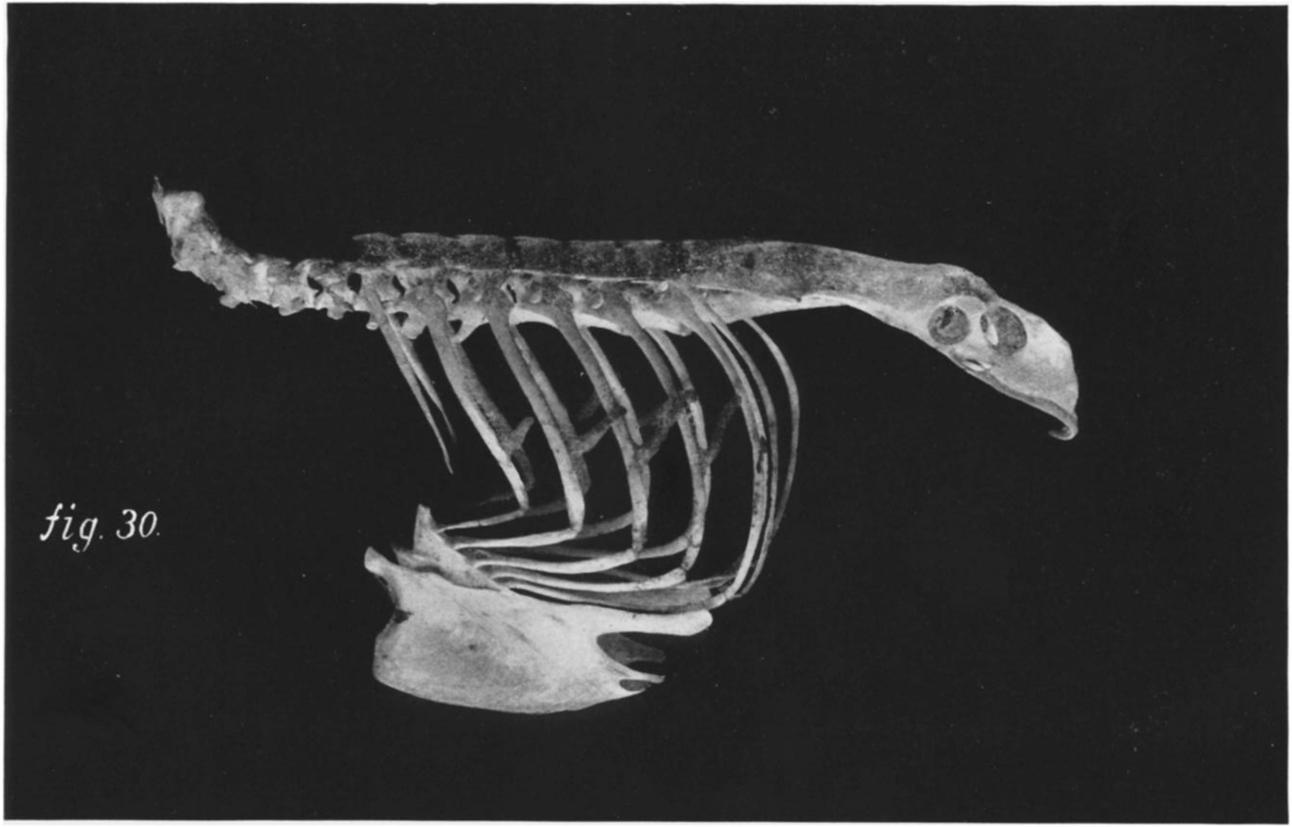

fig. 30.